AUTOMOBILE ENGINEER

DESIGN · PRODUCTION · MATERIALS

Vol. 42 No. 550. FEBRUARY, 1952 PRICE : 3s. 6d.

Coil Springs

All stages of production — melting, rolling, heat treatment and final manufacture into the spring — are under the constant supervision of experts.

The Wickman Mobile Demonstration Unit brings skilled help right to the factory floor. Staffed by a team of specialist instructors, the Unit is fully equipped with machine tools for reservicing carbide tools, and many Wimet users have already availed themselves of this opportunity to train operators and executives in the correct methods of applying and servicing these tools. Demonstrations on the design, application and servicing of Wimet tools have been given to over 2,000 operators and, in addition, lectures, supported by sound films and film strips, have been attended by more than 1,000 operators.

The greatest productivity from carbide tooling can only be obtained when operators know the right grade to choose, the right time to withdraw tools from use for reservicing, the right wheels and methods—in fact, the right carbide technique.

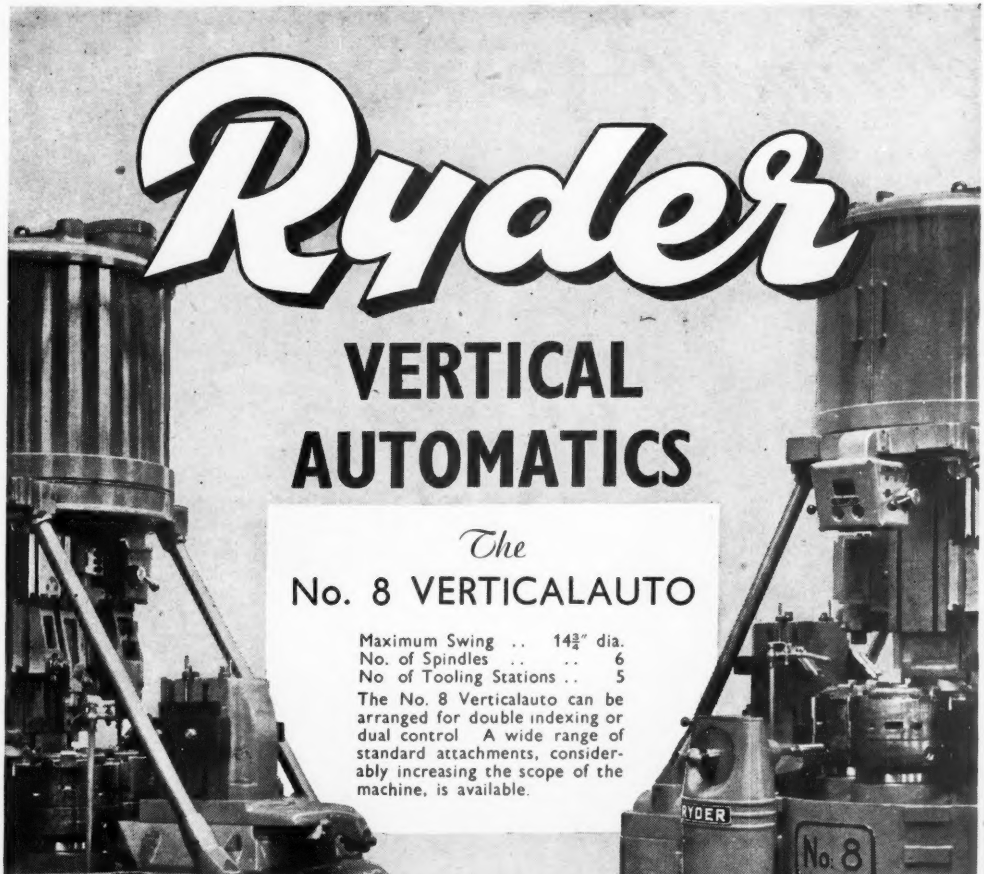
This is just one of the ways Wickman's are helping Wimet users to get the best out of carbide tooling.

WICKMAN *of* COVENTRY

LONDON · BRISTOL · BIRMINGHAM · MANCHESTER
LEEDS · GLASGOW · NEWCASTLE · BELFAST

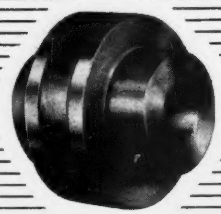
Wimet

215 ST

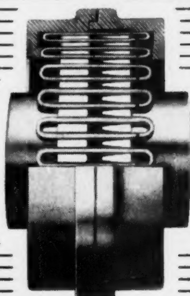

Ryder
VERTICAL AUTOMATICS
The No. 8 VERTICALAUTO
Maximum Swing .. 14¾″ dia.
No. of Spindles 6
No of Tooling Stations .. 5
The No. 8 Verticalauto can be arranged for double indexing or dual control A wide range of standard attachments, considerably increasing the scope of the machine, is available.
RYDER
No. 8
RYDER
Built by
THOMAS RYDER & SON, LTD.
TURNER BRIDGE WORKS, BOLTON
Wickman
Sole Selling Agents
WICKMAN of COVENTRY


THE NICKEL BULLETIN
A SUMMARY OF CURRENT INFORMATION ON NICKEL

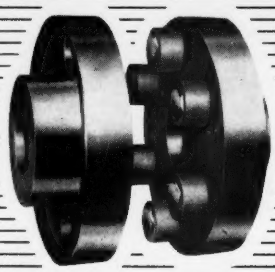
★ **AN INDISPENSABLE FEATURE OF MODERN POWER TRANSMISSION・・**



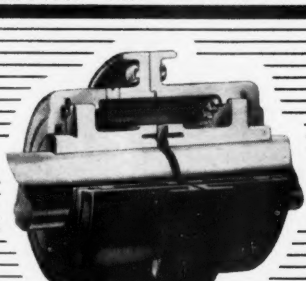
PERFECT



MULTIFLEX



CROWN PIN



INTERNAL GEAR

Crofts FLEXIBLE COUPLINGS

★ **Selection of the correct type of Flexible Coupling to protect Driving and Driven Machinery from shocks, sudden overloads, misalignment, etc., is of the greatest importance to ensure Highest Efficiency in Power Transmission.**

★ **Our catalogue CF.249/1 lists all types of Couplings and gives essential information regarding applications.**

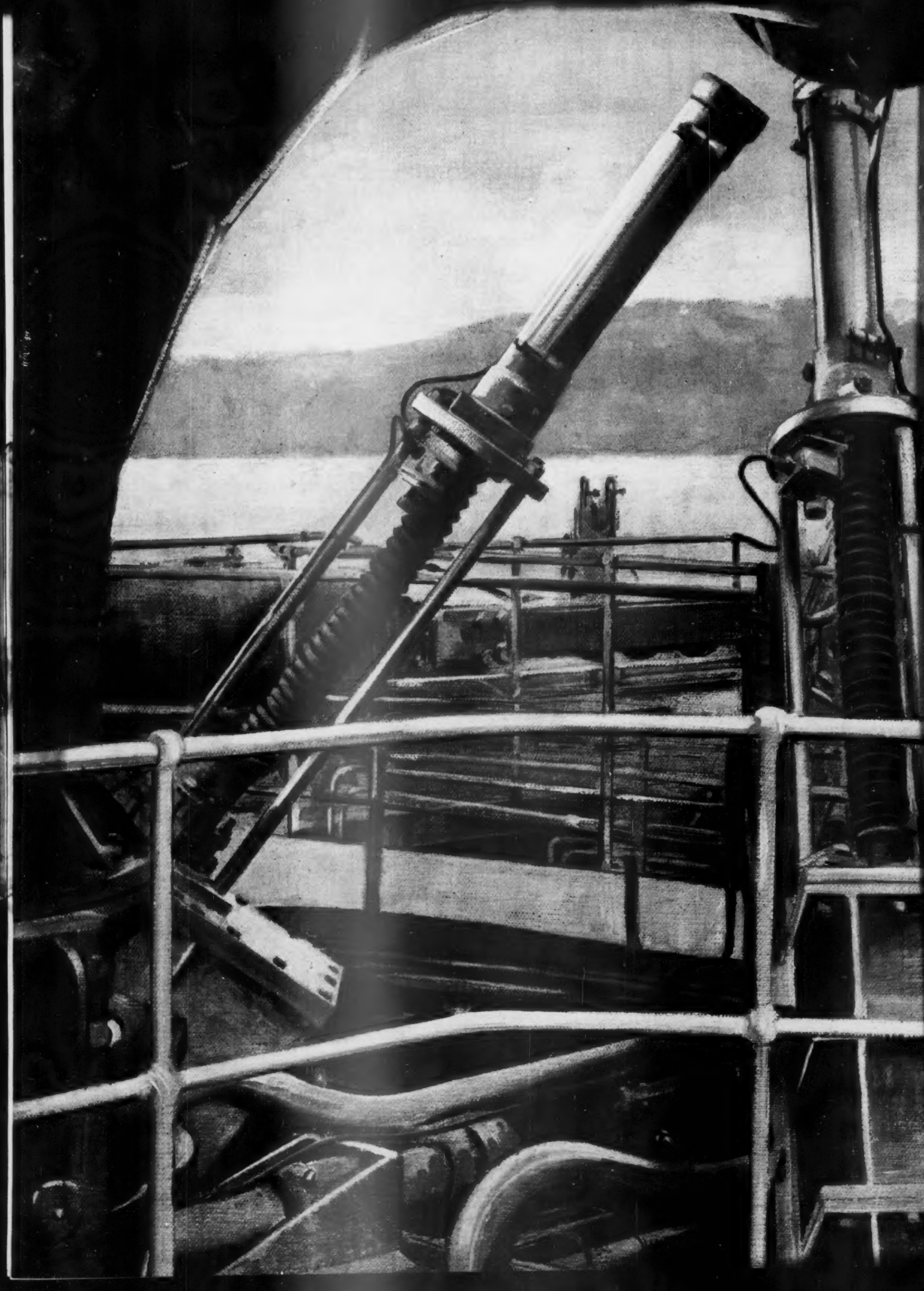
Crofts

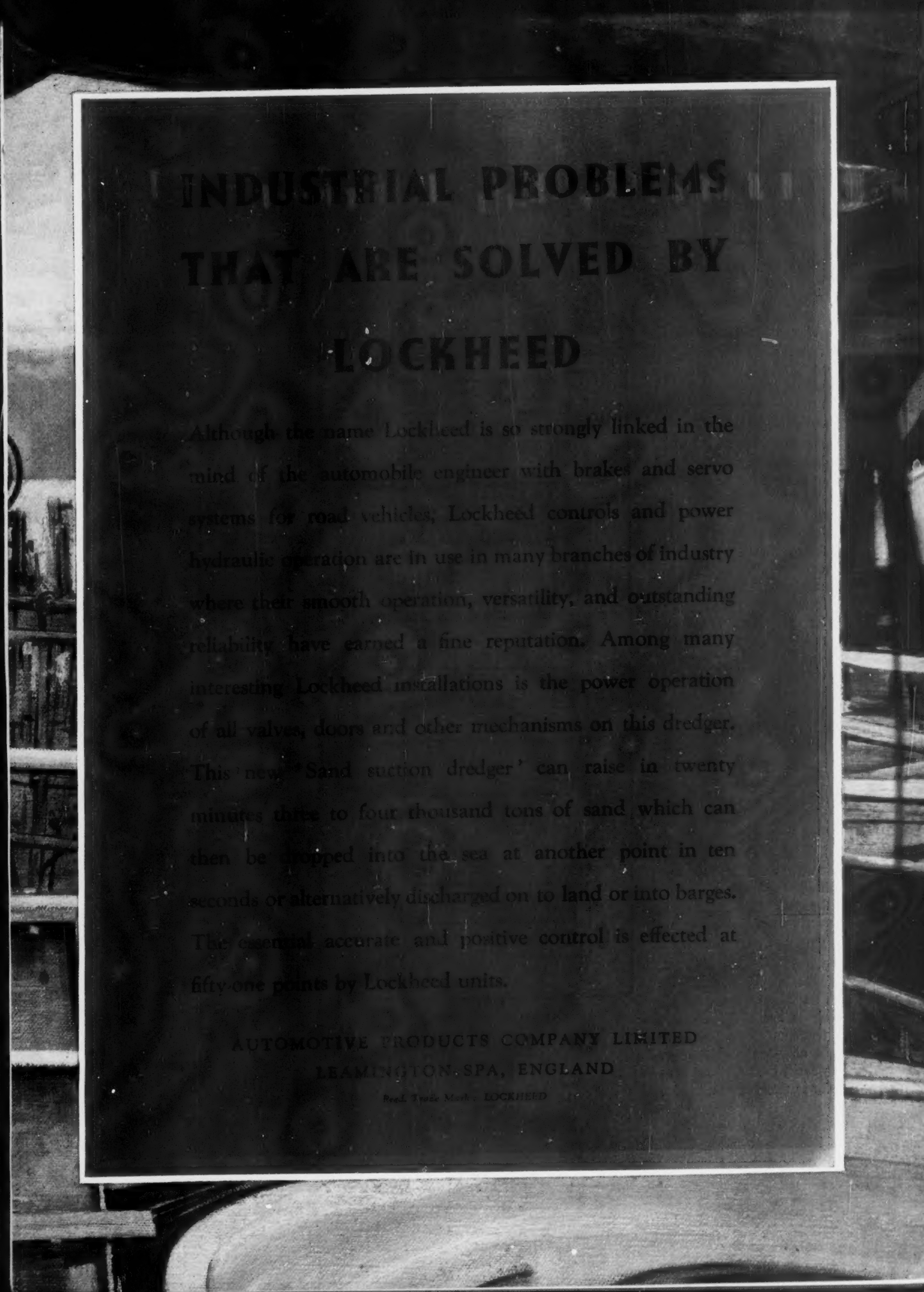
CROFTS (ENGINEERS) LTD., BRADFORD

PHONE — 65251 (10 LINES) GRAMS — "CROFTERS BRADFORD"

G 1089


LARGE
PRIVATE
Sentinel
BORG & BECK
FULLY
PATENTED
SMALL




INDUSTRIAL PROBLEMS
THAT ARE SOLVED BY
LOCKHEED
Although the name Lockheed is so strongly linked in the mind of the automobile engineer with brakes and servo systems for road vehicles, Lockheed controls and power hydraulic operation are in use in many branches of industry where their smooth operation, versatility, and outstanding reliability have earned a fine reputation. Among many interesting Lockheed installations is the power operation of all valves, doors and other mechanisms on this dredger. This new 'Sand suction dredger' can raise in twenty minutes three to four thousand tons of sand which can then be dropped into the sea at another point in ten seconds or alternatively discharged on to land or into barges. The essential accurate and positive control is effected at fifty-one points by Lockheed units.
AUTOMOTIVE PRODUCTS COMPANY LIMITED
LEAMINGTON SPA, ENGLAND
Regd. Trade Mark : LOCKHEED

SOME STEERING GEOMETRY PROBLEMS

Braking reaction

It is rarely that equal retarding forces act upon both front wheels during braking. When braking is light this is relatively unimportant since the resultant forces tending to deflect the car from its original direction of travel are small. Heavy braking increases both the effects of unequal braking forces and the probability of such inequality, either because of momentarily unequal wheel loading or of unequal limiting adhesion between the two tyres and the road. It is to be assumed that the brakes are above reproach and incorporate the present-day refinements of the brake specialist, namely, efficient low-loss actuation giving the best possible balance: the use of brake linings having the most consistent coefficient, and brake-shoe geometry having the least possible sensitivity to any change in the coefficient, and accurate dimensional control of such geometry in manufacture.

Let us first consider a hypothetical car without steering pivots and therefore without flexible linkages restraining the front wheels from moving about such pivots. Unequal braking forces on the two front wheels would result in deviations from the straight-ahead, since such unequal forces produce a turning moment on the vehicle which can only be resisted by inducing drift angles on the tyres. The attitude engendered by the persistence of these drift angles for only a short time is enough to change the direction of drift angle on the front wheels, and it only requires a sufficient initial impulse, and possibly a little oversteer, for the car to turn completely round. One conclusion might reasonably be drawn from this, that except in the interests of experimental verification of the above thesis it would be inadvisable to slam on the brakes and to hold the steering wheel rigidly in the straight ahead position!

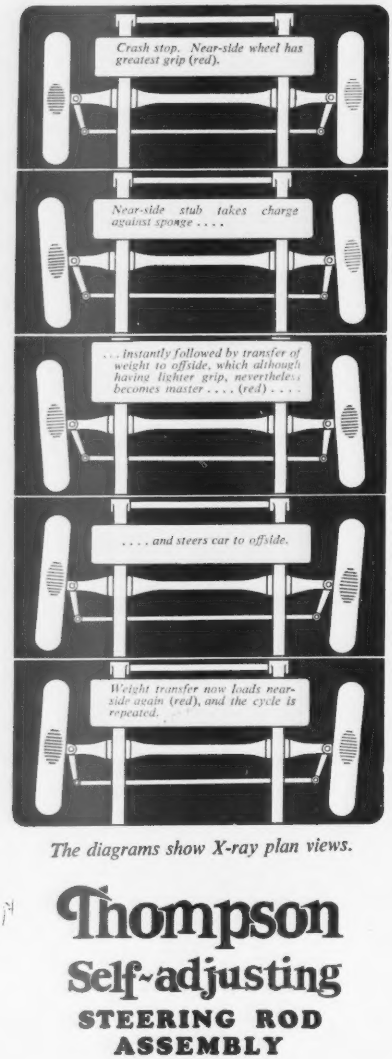
When we restore the temporarily-abolished kingpin pivots and flexible restraining linkages, then although the initial effect of the unequal braking forces on the two front wheels is the same as has been indicated above, a tendency to deviate from the straight ahead, the subsequent events may easily be different. Let us suppose, for instance, that a vehicle weighing 5,000 lb. is being retarded at 0·8 g and that the now usual distribution of braking front to rear, 60% to 40% occurs, then the total retarding force on the two front wheels is 0·6 of 4,000 lb. or 2,400 lb. Suppose further that 1,600 lb. of this is provided by one wheel and 800 lb. by the other. If the offset between kingpin and contact ' points ' at the ground is 2 in., then the resultant torque about the kingpins is 800 x 2 = 1,600 lb. ins. = 133 lb. ft. With a steering linkage flexibility of 800 lb. ft. per degree, the resulting deflection of the wheels will be one sixth degree, and this, at 70 m.p.h. and with a 9 ft. wheelbase, produces a sideways acceleration of approximately 0·1 g and a resulting load difference between the two front wheels of about 160 lb., the greater load now falling on the front wheel which was originally subjected to the lesser retarding force. It must be obvious that there is now a possibility of that wheel developing the greater retarding force and so producing a swerve in the opposite direction, which then results in a reversal of the load difference and a subsequent further swerve in the original direction. There is, in fact, a possibility of building up a self-intensive wobble if flexibilities and frequencies match up, as they may possibly do.

Geometry errors may of course accentuate the steering deflections on which such a wobble depends and so aggravate the condition.

Road conditions may also produce the wobble if they result in alternate out-of-phase light and heavy loadings on the front wheels; a corrugation running diagonally across the path of the car so that one front wheel is in the valley while the other is on the crest would, for instance, produce the desired combination of loads and the appropriate relationship between pitch of corrugation and speed of car would match the frequency involved.

This is something which can occur with I.F.S. as distinct from the ' tramp ' which occurs with a front axle and is often excited by braking.

The diagrams, shown with reference to a front axle, apply equally well to a car with I.F.S.



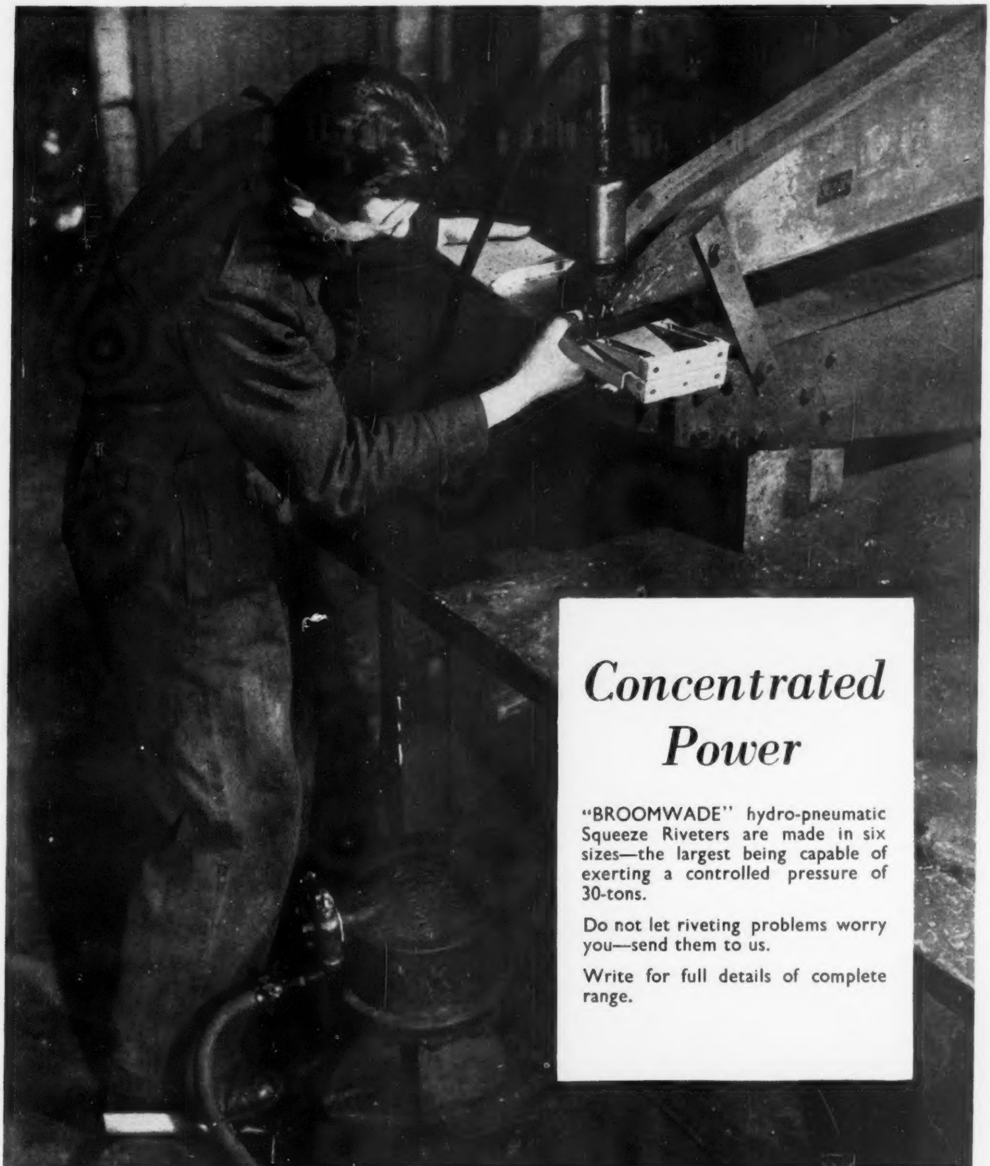
The diagrams show X-ray plan views.

Thompson

Self-adjusting

STEERING ROD ASSEMBLY

AUTOMOTIVE PRODUCTS COMPANY LIMITED, LEAMINGTON SPA, ENGLAND



Concentrated Power

"BROOMWADE" hydro-pneumatic Squeeze Riveters are made in six sizes—the largest being capable of exerting a controlled pressure of 30-tons.

Do not let riveting problems worry you—send them to us.

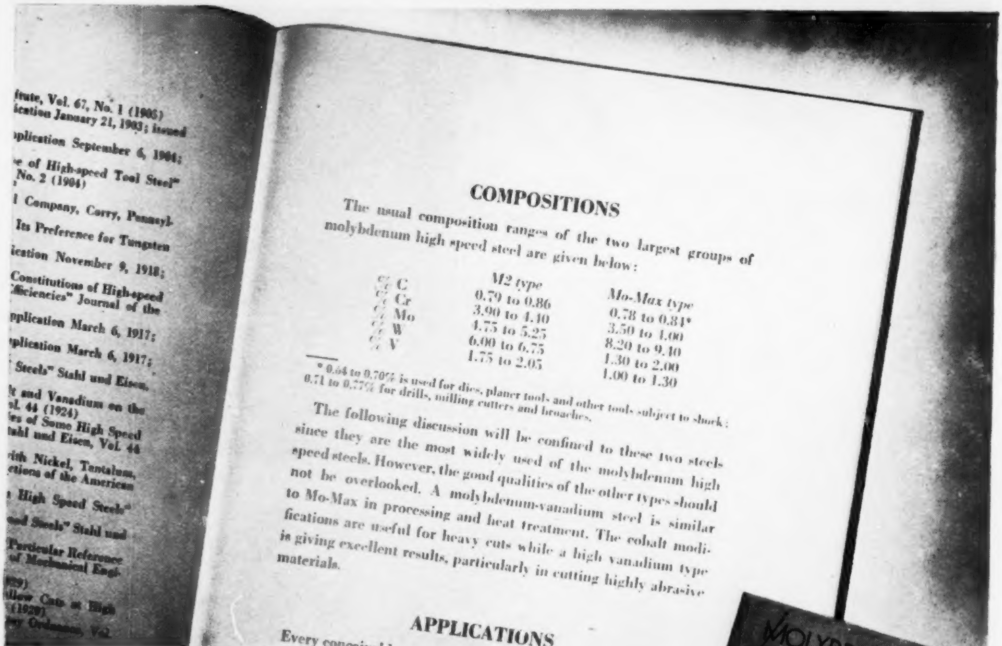
Write for full details of complete range.

"BROOMWADE"

BROOM & WADE LTD., HIGH WYCOMBE, ENGLAND. Telephone: High Wycombe 1630 (8 lines). Telegrams: "Broom," High Wycombe.

95

MOLYBDENUM HIGH SPEED STEELS



COMPOSITIONS

The usual composition ranges of the two largest groups of molybdenum high speed steel are given below:

	M2 type	Mo-Max type
% C	0.79 to 0.86	0.78 to 0.84*
% Cr	3.90 to 4.10	3.50 to 4.00
% Mo	4.75 to 5.25	8.20 to 9.10
% W	6.00 to 6.75	1.30 to 2.00
% V	1.75 to 2.05	1.00 to 1.30

* 0.64 to 0.70% is used for dies, planer tools and other tools subject to shock; 0.71 to 0.77% for drills, milling cutters and broaches.

The following discussion will be confined to these two steels since they are the most widely used of the molybdenum high speed steels. However, the good qualities of the other types should not be overlooked. A molybdenum-vanadium steel is similar to Mo-Max in processing and heat treatment. The cobalt modifications are useful for heavy cuts while a high vanadium type is giving excellent results, particularly in cutting highly abrasive materials.

APPLICATIONS

— WILL WIN ON MERIT

Despite the present difficult situation, make no mistake, Molybdenum High Speed Steels with their superior performance will eventually come out on top.

Some of the reasons why are given in this 30 page Technical Booklet, which deals with compositions, applications, performance and treatment.

Write now for a copy. It is available free on request to tool manufacturers and users.

Climax Molybdenum Company of Europe Ltd.

Technical enquiries for this book, preferably with full details of the projected application of Molybdenum steel, should be addressed to:

99 Pinstone St. Sheffield, 1.

(*Registered Office:* 2-3 Crosby Square, London E.C.3.)

Please send your FREE Booklet

"MOLYBDENUM HIGH SPEED STEELS"

BLOCK LETTERS PLEASE

Name ....

Position ....

Company ....

Address ....

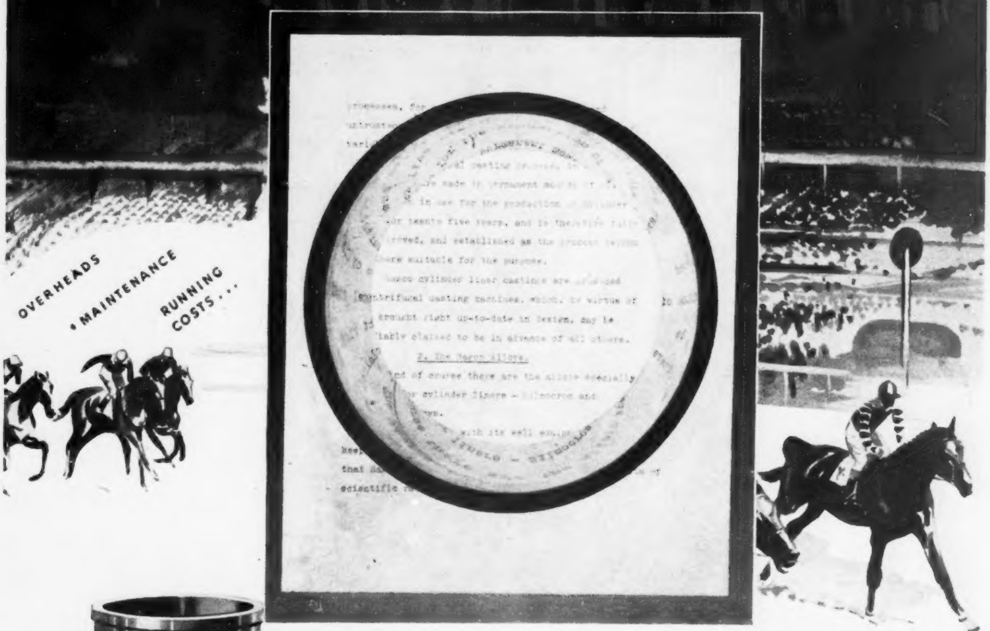
AE2

HS7


SIGMA
COMPARATORS
MECHANICAL
Accurate, sensitive, robust: for single dimension checking or turret type to check up to 10 dimensions at one setting.
ELECTRICAL
For checking to extremely fine tolerance.
Magnification up to 50,000 X.
Suitable for control of slip gauges.
PNEUMATIC
For high precision measurement of small internal diameters. Will also check concentricity.
FULL PARTICULARS ON REQUEST.
MAKERS:
The Sigma Instrument Co. Ltd., Letchworth.
DEMONSTRATIONS BY APPOINTMENT
SIGMA

PHOTO "FINISH"

proves them well ahead . . .



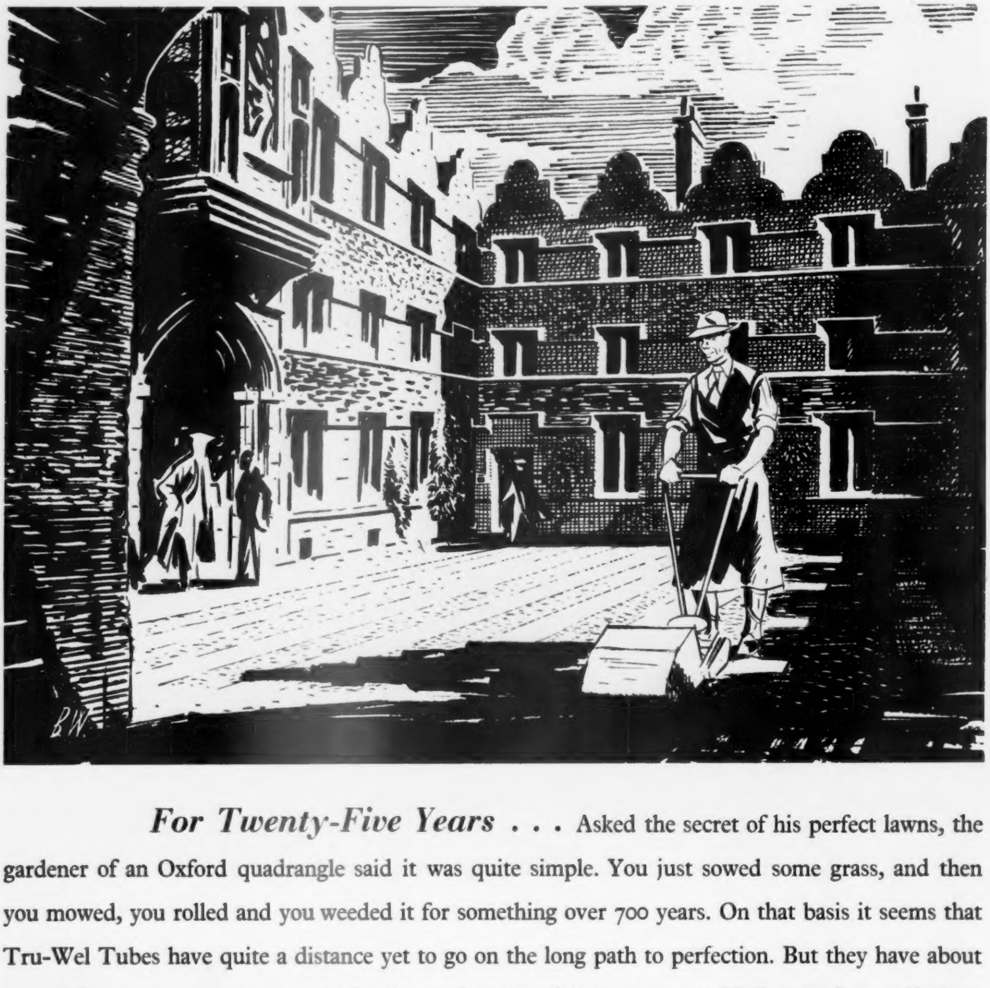
The above photograph of the bore of a HAGCO Liner *after 120,000 miles* graphically shows how the iron has taken such a beautiful "mirror" polish that it reflects perfectly a page of typewriting looked at through the Liner. Conclusive proof to all motor engineers of the infinitesimal wear, and the outstanding resistance to abrasive action, of HAGCO "Silmocrom" and "Austenitic" Cylinder Liners.

HAGCO
Cylinder
LINERS

Stellited Valves & Valve Seatings

HAROLD ANDREWS GRINDING CO., LTD., BRISTOL ROAD, BOURNBROOK, BIRMINGHAM, 29. *Telephone : SELly Oak 1128-9-0.* **and at MANOR WORKS, MANOR LANE, HALESOWEN.** *Telephone : HALesowen 1181-2.*

The long path to perfection



For Twenty-Five Years . . . Asked the secret of his perfect lawns, the gardener of an Oxford quadrangle said it was quite simple. You just sowed some grass, and then you mowed, you rolled and you weeded it for something over 700 years. On that basis it seems that Tru-Wel Tubes have quite a distance yet to go on the long path to perfection. But they have about twenty-five years start on everybody else, and most of their users are kind enough to call them almost perfect now. Tru-Wel's uniformity of strength, concentricity, wall thickness and composition is *precisely* what every assembly line requires.

tested ... tried ... trusted

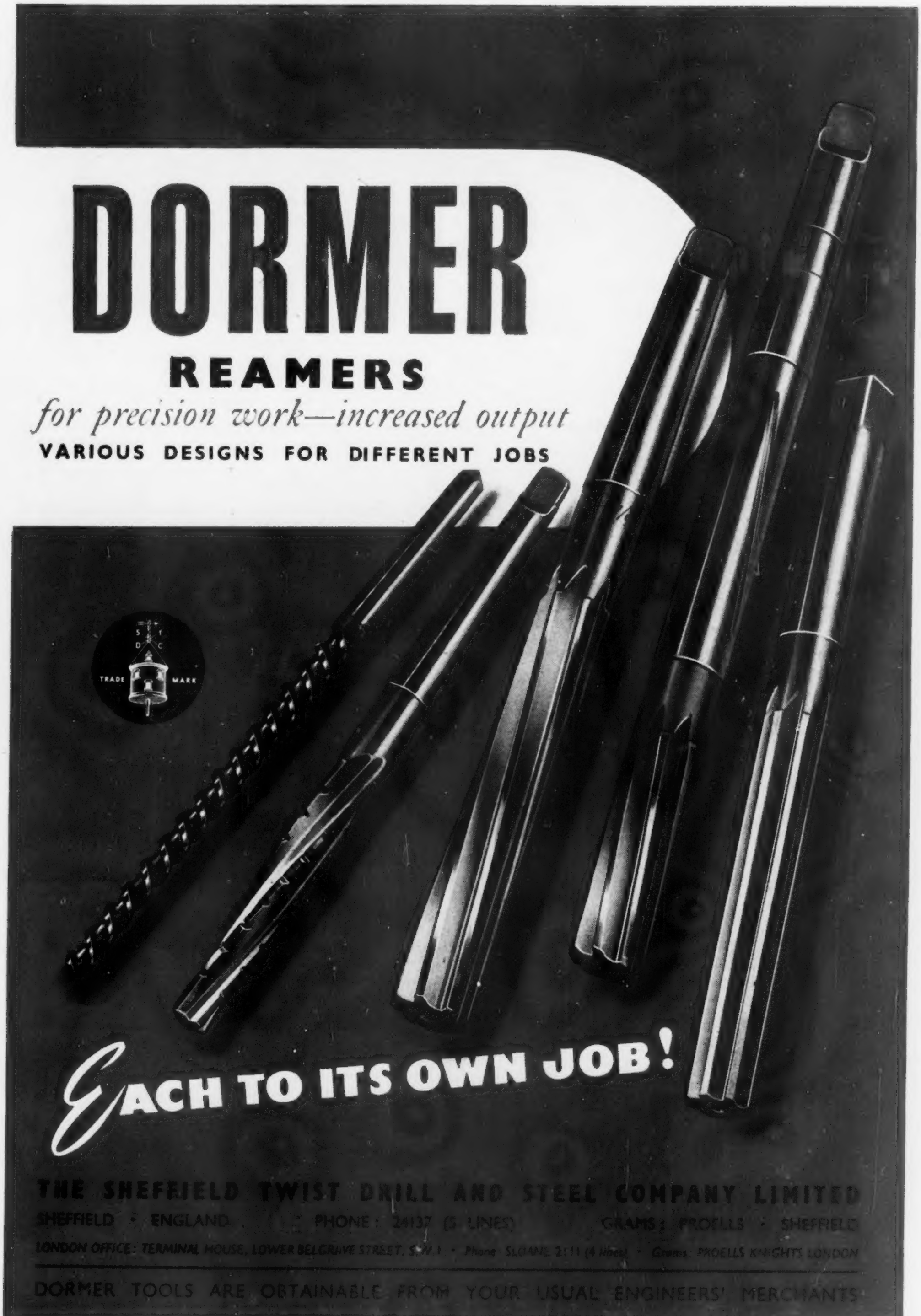
TRU-WEL

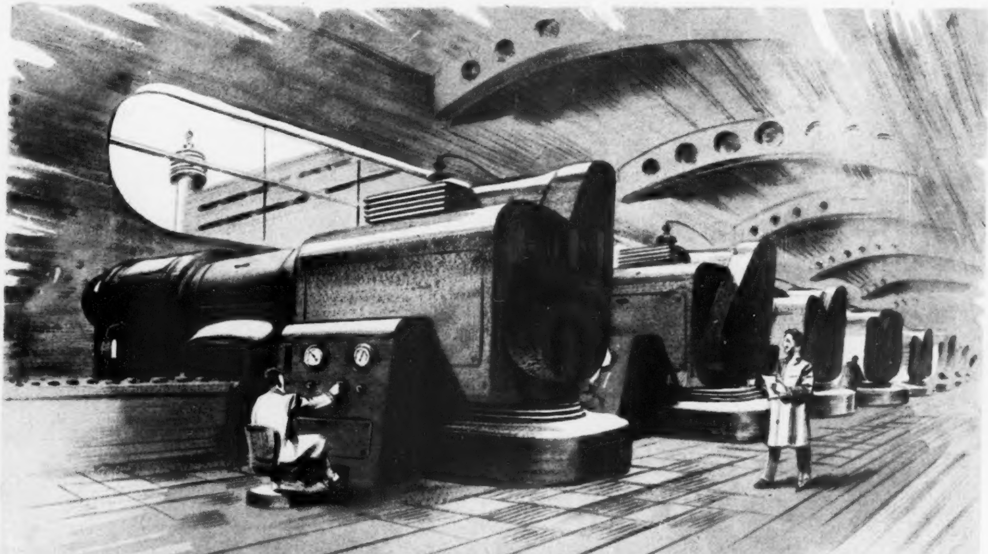
ELECTRICALLY WELDED STEEL TUBES

Tru-Wel ELECTRICALLY WELDED Steel Tubes
Supplied in straight lengths from $\frac{1}{8}$" o/d to $4\frac{3}{4}$" o/d in gauges 22 to 6, or manipulated to your special requirements. Also available in a range of standard sections.

Tru-Wel STAINLESS STEEL Tubes
Made from Austenitic steels of the 18% chromium 8% nickel type. In straight lengths $\frac{1}{2}$" o/d to 2" o/d in gauges 20 to 12, or manipulated to measure.

A TI COMPANY TUBE PRODUCTS LTD., OLDBURY, BIRMINGHAM


DORMER
REAMERS
for precision work—increased output
VARIOUS DESIGNS FOR DIFFERENT JOBS
TRADE MARK
EACH TO ITS OWN JOB!
THE SHEFFIELD TWIST DRILL AND STEEL COMPANY LIMITED
SHEFFIELD · ENGLAND PHONE: 24137 (5 LINES) GRAMS: PROELLS · SHEFFIELD
DORMER TOOLS ARE OBTAINABLE FROM YOUR USUAL ENGINEERS' MERCHANTS



AHEAD OF ACHIEVEMENT—

BALL & ROLLER R&M BEARINGS

THIS MACHINE AGE.

By reason of the advanced design and constant experiment in application, R&M Bearings have always been to the forefront in the Machine Tool Industry where the demand is for ever increasing speed of production, together with greater precision of the parts produced.

For higher duty machines for to-morrow's designs, you will assuredly find bearings to these requirements in the R&M Comprehensive Range.

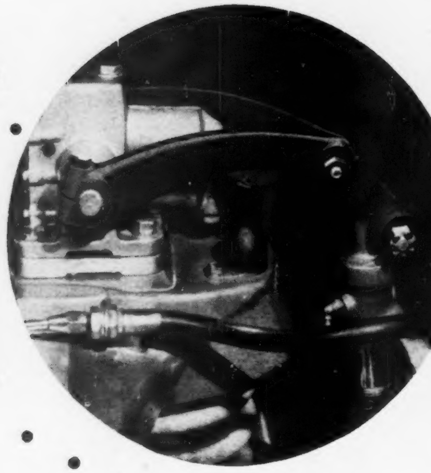
RANSOME & MARLES BEARING CO., LTD., NEWARK-ON-TRENT, ENGLAND

K/RM 85

points of stress . . .

are strong points . . . .

with Smethwick Drop Forgings



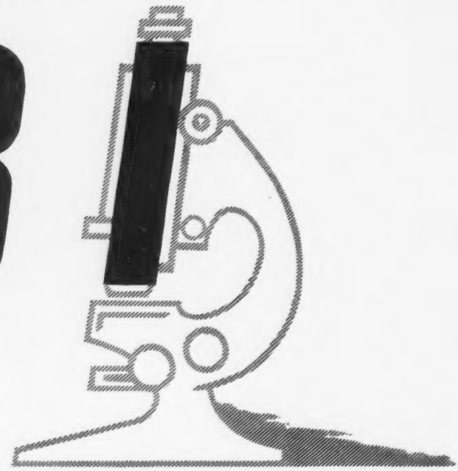
SDF

SMETHWICK DROP FORGINGS LTD · SMETHWICK & KIDDERMINSTER ENGLAND


INGENUITY IN
Rubber Bonded to Metal
Bonded Rubber Automobile Mountings
For damping vibration in private car or heavy goods vehicle, the bonded rubber mounting provides a simple and effective answer.
As designers and producers of resilient mountings for the leading automobile manufacturers, ANDRE RUBBER can offer technical service and production facilities second to none.
If vibration is your problem—send it to us!
Three acres of Specialised Rubber Technology
ANDRE RUBBER
ANDRE RUBBER COMPANY LIMITED (A SILENTBLOC COMPANY)
KINGSTON BY-PASS, SURBITON, SURREY Telephone: ELMBRIDGE 6580/3 Telegrams: ANDRE SURBITON
TAS/AR69

THE

F B I



IS WATCHING OUT FOR YOU

But don't be alarmed, F.B.I. in this case stands for Ferodo Batch Investigation — and it's your *interests* that are being watched.

From every batch of Ferodo friction materials, samples are taken and ruthlessly tested for efficiency and durability. On the M.I.R.A. Track (of which Ferodo Limited are one of the largest users) the final and practical proving of the finished product takes place. All this, and the ceaseless experimental work in the Ferodo Test House, ensures that Ferodo friction materials maintain their high standard of reliability, efficiency and durability that makes them first choice for safety all over the world.

We freely and cordially invite British and Overseas Automobile Engineers to make full use of the Ferodo Test House.

FERODO

BRAKE & CLUTCH LININGS

FERODO LIMITED CHAPEL-EN-LE-FRITH *A Member of the Turner & Newall Organisation*

EATON AXLES LIMITED

25, VICTORIA STREET, LONDON, S.W.1., ENGLAND

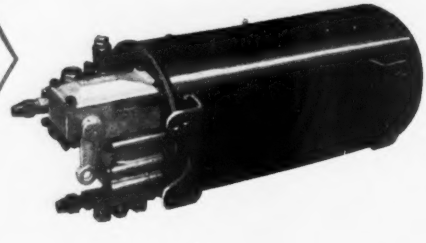
EA 23

CLAYTON DEWANDRE
STORAGE & CONTROL UNITS

APGA.4436A

Single Air Pressure Reservoir complete with Brake and Unloader Valves for normal brake application.

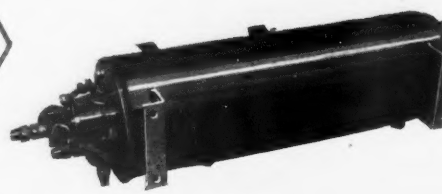
Fitted to A.E.C. 'Matador' and 'Mammoth Major' Vehicles.



APGA.4420-1

Twin Air pressure Reservoir complete with Composite Valve, providing a quick available reserve of air pressure for power braking and gearbox operation, as well as air storage at maximum pressure.

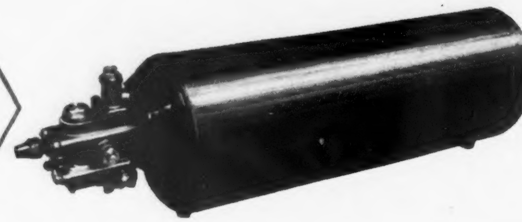
Supplied for London Transport's R.T. type buses.



APGA.4416

Single Air Reservoir complete with Unloader and Safety Valves—recommended for all types of road vehicle.

Supplied to Messrs. Scammell Lorries Ltd. for their cross-country 6 x 6 vehicles.



APGA.4434

Single Air Pressure Reservoir complete with Brake, Change-Speed and Unloader Valves providing air for brake and gearbox operation.

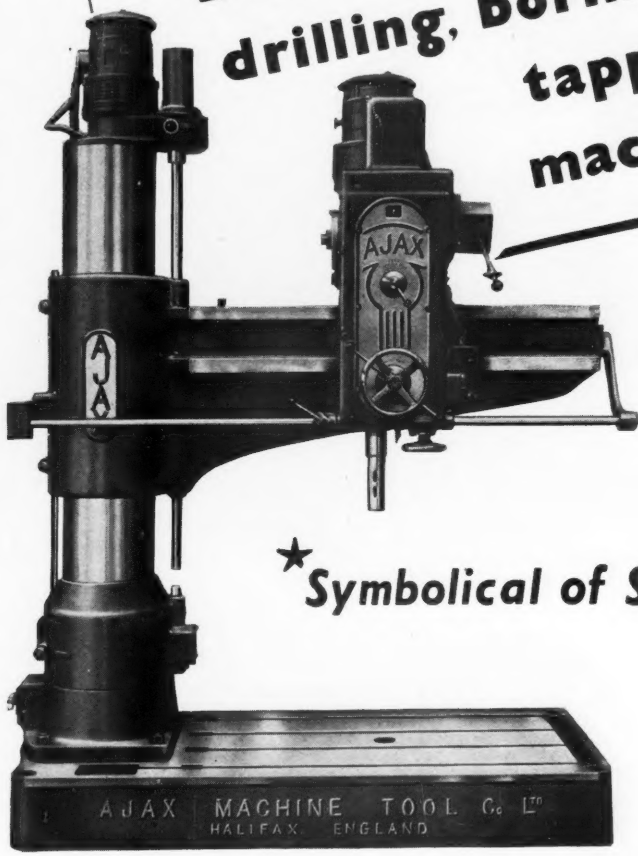
Fitted to A.E.C. 'Regent' and 'Regal' Mark III Chassis.

FOR AIR PRESSURE BRAKING

CLAYTON DEWANDRE CO. LTD. TITANIC WORKS LINCOLN 11305·9

A.P.9

*AJAX radial drilling, boring & tapping machine



*Symbolical of Strength

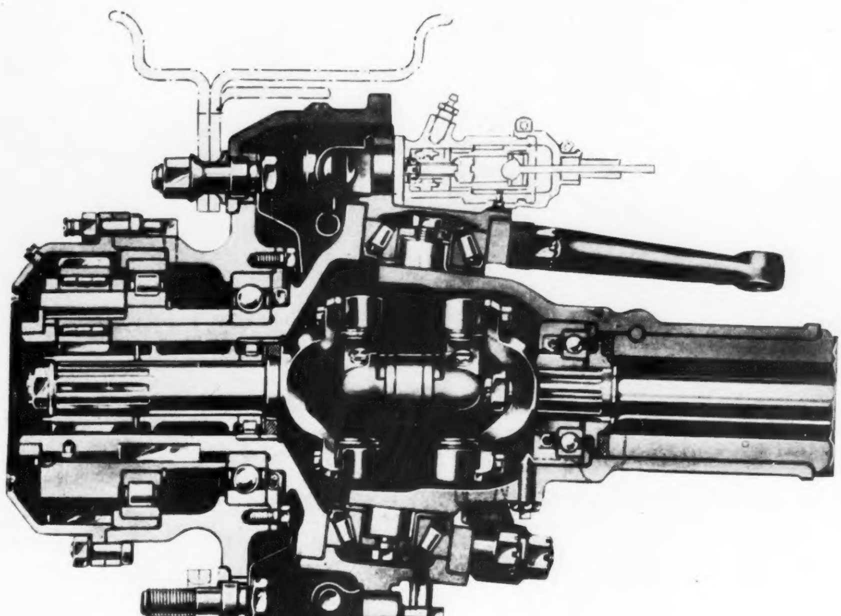
4′ 6″, 5′ and 5′ 6″ sizes.
3′, 3′ 6″ and 4′ saddle traverses.
8 speeds in choice of 3 ranges.
4 rates of power feed at each speed.
1⅝″ dia. spindle with 14″ feed.

3″ capacity in cast iron.
Completely electrified. No friction clutches.

Write for leaflet AJ4 to:
Ajax Machine Tool Co. Limited,
West Mount Works, Halifax, Yorks.
Proprietors: ADA (Halifax) Ltd.

AJAX MACHINE TOOLS

KIRKSTALL AXLES



FRONT WHEEL DRIVE

KIRKSTALL FORGE ENGINEERING LTD
LEEDS

Telephone : Horsforth 2821

Electric fork truck with hydraulic squeeze clamp attachment

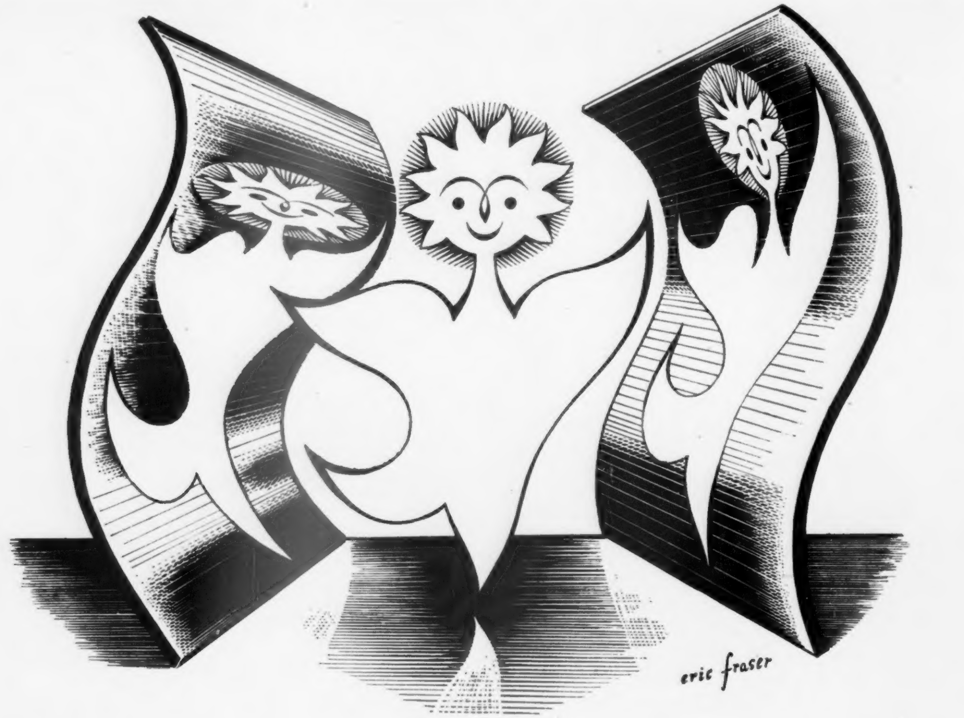
One man built this wall

ONE MAN, using a battery electric fork lift truck, transported and stacked these packages . . . . one man with electric power instead of the team of men which would be needed without it. Electric trucks, their batteries charged over-night, take off-peak power for peak-hour work. Silent, easily and precisely controlled, *they save labour, time and factory space, by making efficient use of the available power supply.*

WHERE TO GET MORE INFORMATION
Your Electricity Board will be glad to help you to get the utmost value from the available power supply. They can advise you on ways to increase production by using Electricity to greater advantage—on methods which may save time and money, materials and coal, and help to reduce load shedding. Ask your Electricity Board for advice: it is at your disposal at any time.

Electricity *for* PRODUCTIVITY

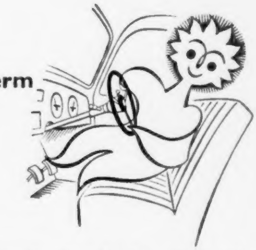
Issued by the British Electrical Development Association



'FLEXIBLE' IS MY MIDDLE NAME! says Mr. Therm

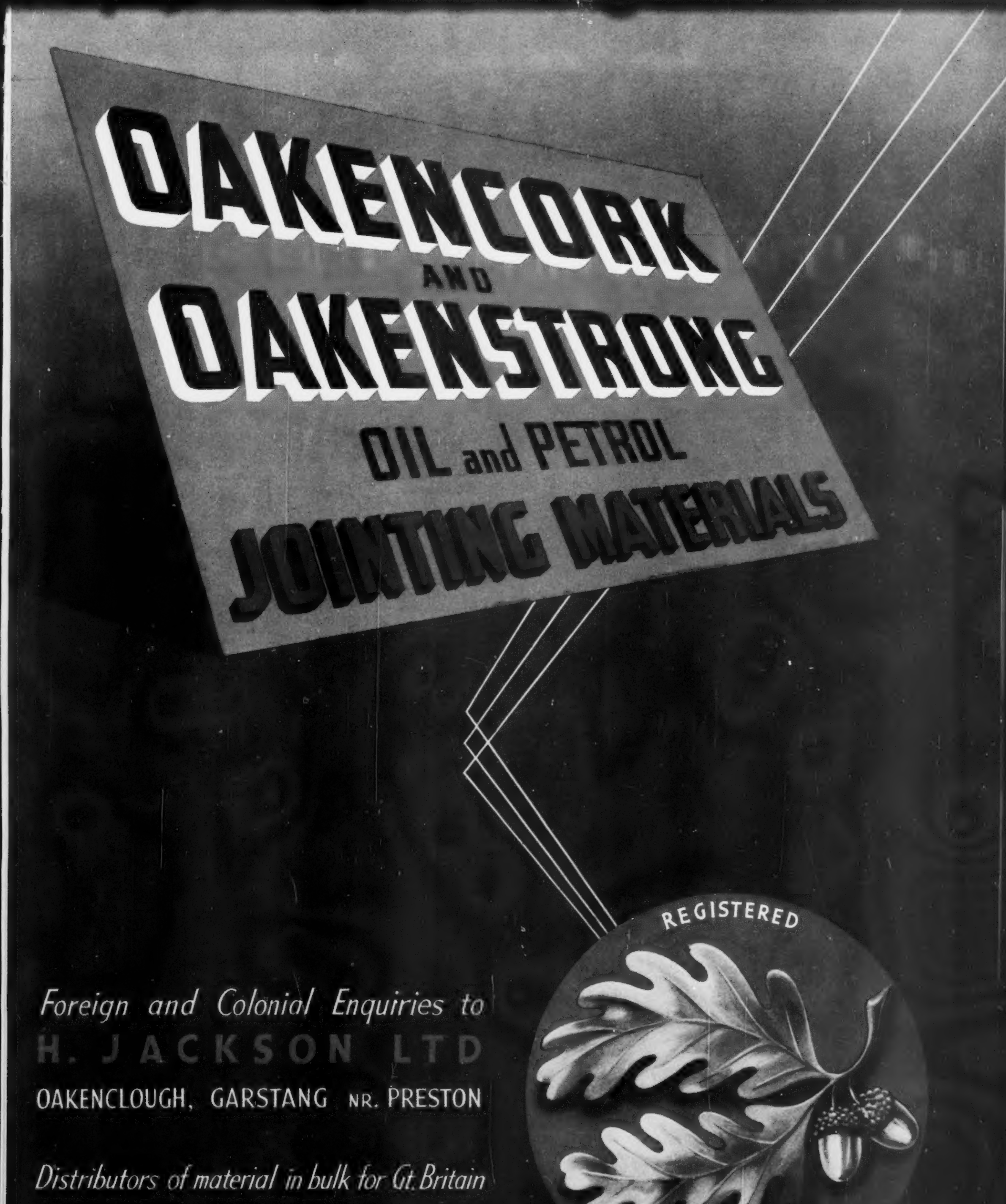
The gas and gas-heated equipment that Mr. Therm brings in his train are amazingly flexible in their applications to all sorts of heating problems. What other fuel but gas could give you a tiny—but steady—pin-point of flame or full heat the instant you want it? And gas can be controlled at the flick of a finger—or can be completely automatic if required. It needs no storage space, is smokeless and ash-free, and works unfailingly for you with remarkable efficiency. No wonder Mr. Therm is to be found hard at work in so many industries!

Mr. Therm takes a front seat

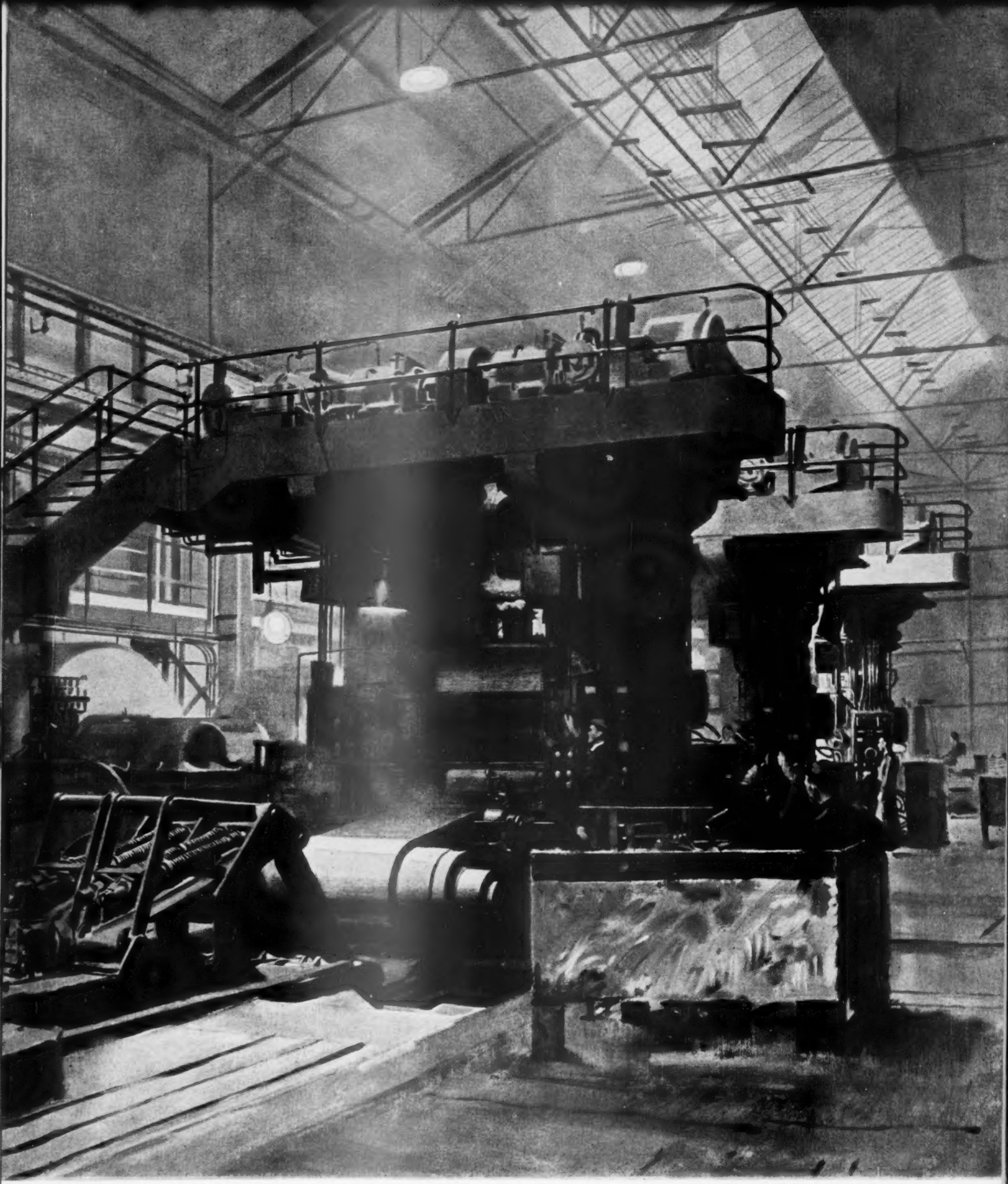


Yes, he's working hard for Briggs Motor Bodies Ltd., at Dagenham. These works concentrate mainly on Ford motor car bodies; and, working to capacity, they'll turn out 400 bodies a day—that means Mr. Therm's kept pretty busy! He lends a hand with annealing, tool hardening, rust proofing, paint drying and finishing, which involve the use of thermostatically controlled gas-heated ovens and furnaces. The 9,000 workers also have Mr. Therm to thank for their meals, which are cooked by gas.

MR. THERM BURNS TO SERVE YOU THE GAS COUNCIL · 1 GROSVENOR PLACE · LONDON · SW1

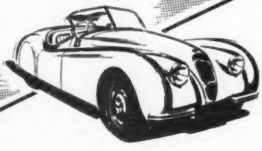

OAKENCORK
AND
OAKENSTRONG
OIL and PETROL
JOINTING MATERIALS
REGISTERED
TRADE MARK
Foreign and Colonial Enquiries to
H. JACKSON LTD
OAKENCLOUGH, GARSTANG NR. PRESTON
Distributors of material in bulk for Gt. Britain
J. A. NORDBERG LTD
171, QUEEN VICTORIA ST. E.C.4

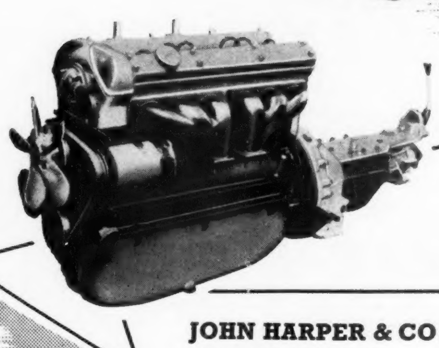

The perfectly
drive.
For Cars, Trucks, Railcars
Aircraft Etc.
Without a
No sliding
No metal to
propeller shaft
LAYCOCK ENGINEERING CO. LTD.



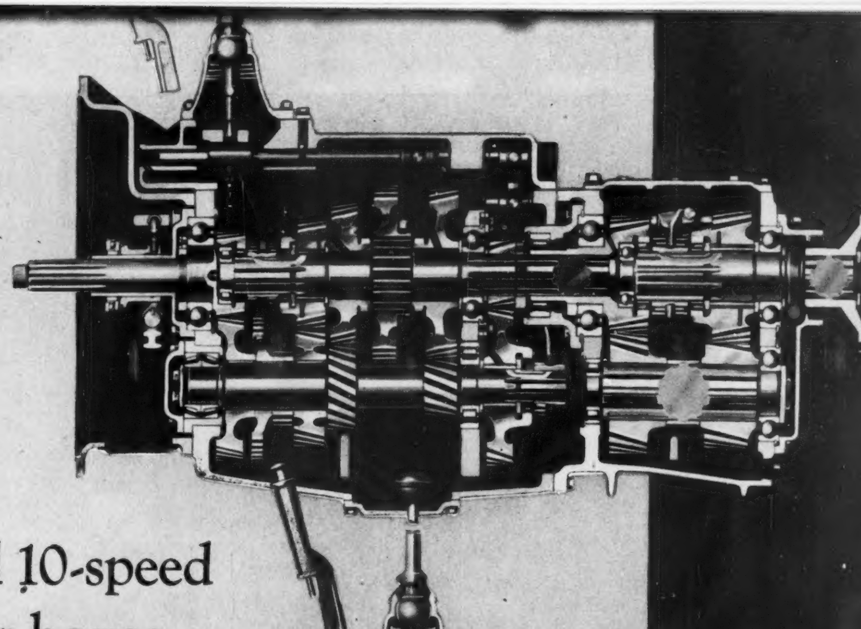
The three-stand tandem cold-reduction mill at Ebbw Vale.

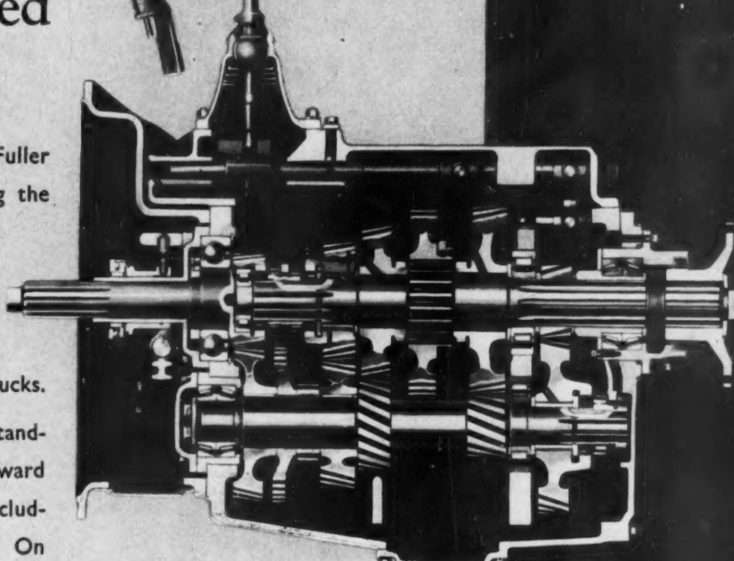
Richard Thomas & Baldwins Ltd. are the largest producers of steel sheets and tinplate in the British Isles.

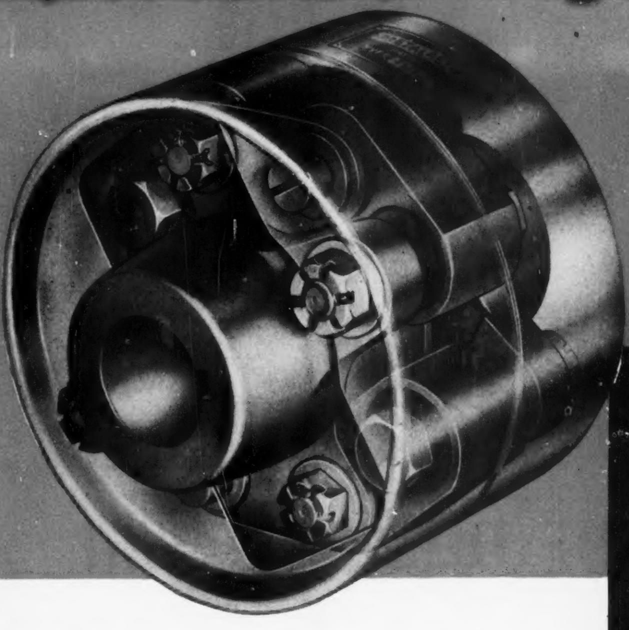


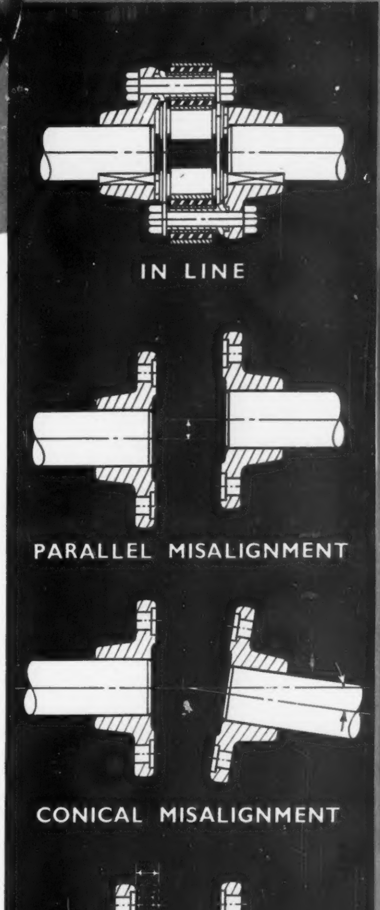



Rod Guide Assembly
Compression Valve Assembly
Piston Assembly







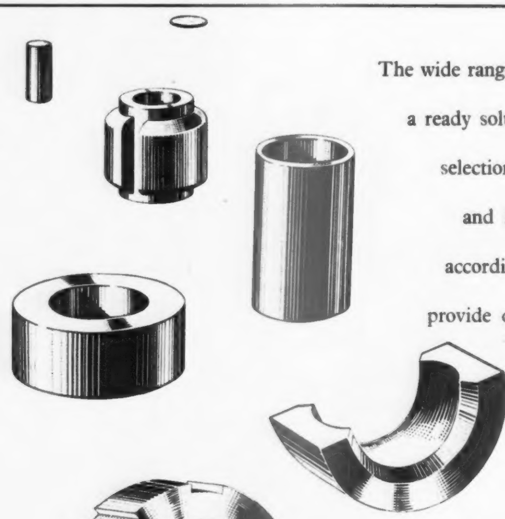


IN LINE
PARALLEL MISALIGNMENT
CONICAL MISALIGNMENT
END FLOAT


renfrew foundries ltd
Suppliers of
Aluminium Alloy Castings
to the
AIRCRAFT INDUSTRY

For Better Machines and Appliances

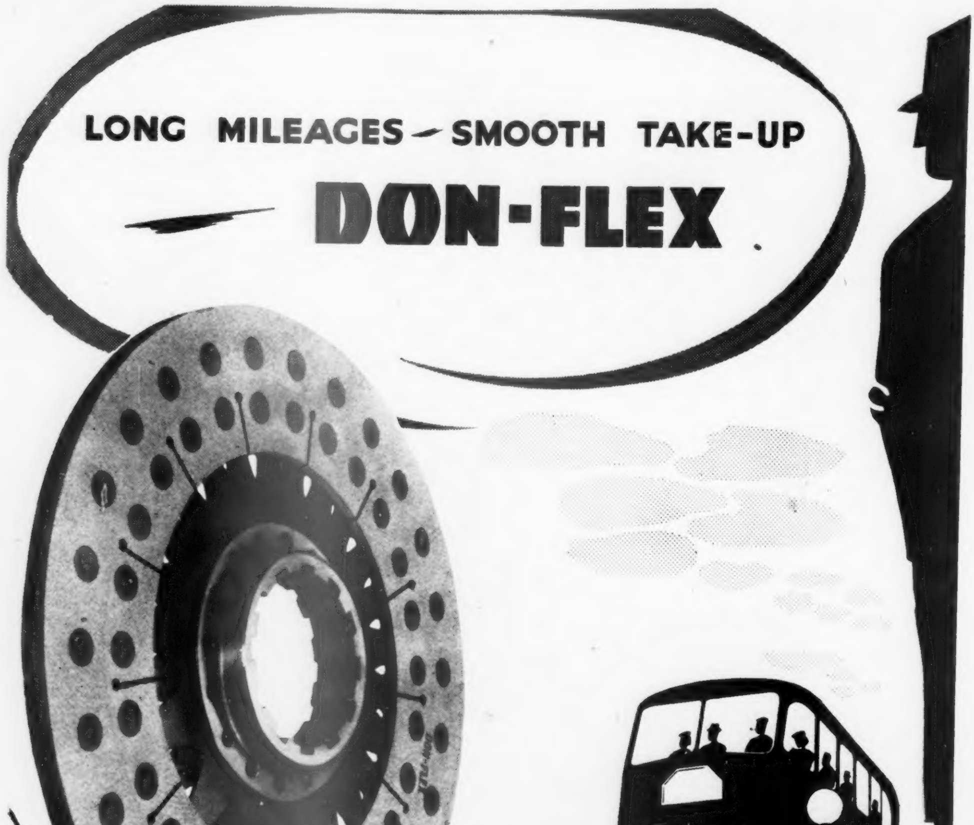
Bound Brook Bearings (G.B.) Ltd



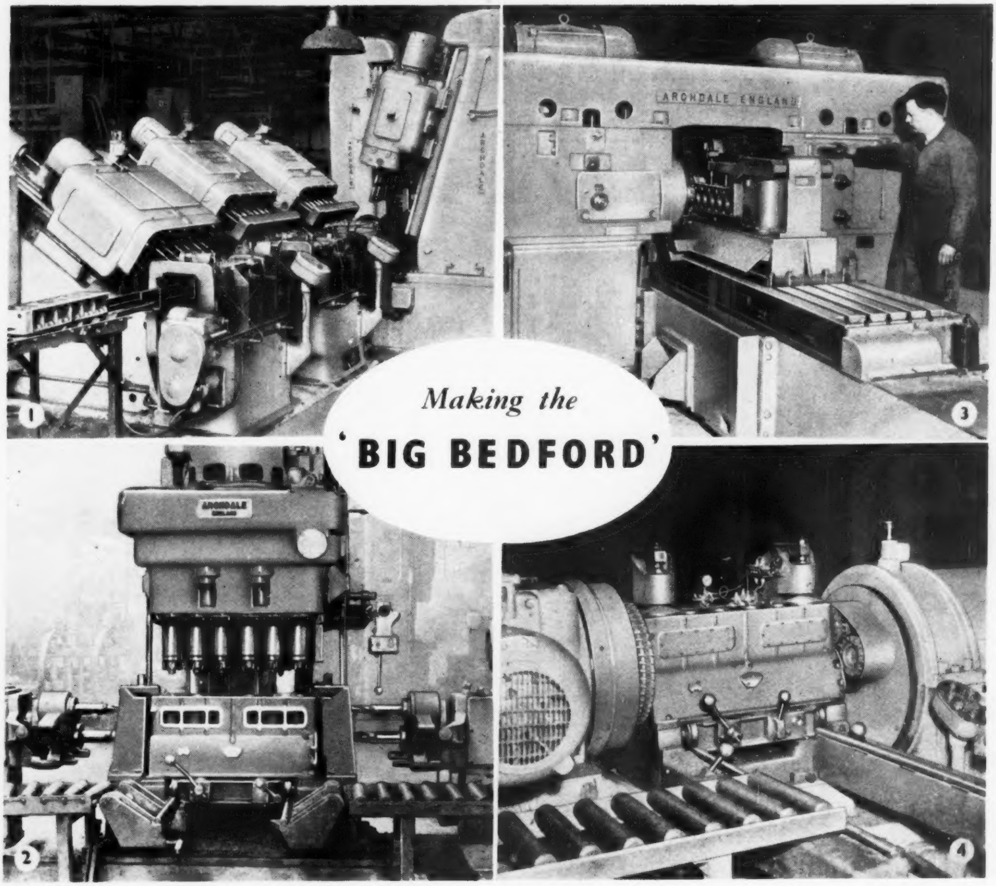
The wide range of Compo oil retaining bearings provides a ready solution to many of the problems of bearing selection. Compo has a porous bronze structure and is impregnated with oil which is exuded according to frictional speed. For bearings that provide complete self lubrication, that give silent service without continual maintenance, that make better machines and appliances, specify Compo.

BOUND BROOK BEARINGS (G.B.) LTD., TRENT VALLEY TRADING ESTATE, LICHFIELD, STAFFS

Telephone: Lichfield 2027, 2028 — *(A Birfield Company)* — *Telegrams: Boundless, Lichfield*


LONG MILEAGES — SMOOTH TAKE-UP
— DON-FLEX.
For complete satisfaction — specify
B·R·M·A
ARE YOU A MEMBER?
DON-FLEX
Patent non-scoring flexible CLUTCH DISC
SMALL & PARKES LIMITED MANCHESTER 9
LONDON: 18, HIGH ST., WIMBLEDON, S.W.19.
MAKERS OF DON BRAKE LININGS

FX53



1. One of two automatic transfer machines for machining cylinder heads. These two machines perform all operations: valve guide holes and throats (leaving for fine boring), and the drilling, facing and tapping of spark plug holes, etc. Work is indexed automatically from station to station: the operator simply loads and unloads.

2. Six-spindle vertical borer or rough boring Cylinder bores. There are also two independent horizontal drilling heads with two spindles for core drilling plug holes and camshaft bores.

3. Special horizontal duplex miller for machining the cylinder head joint face and the sump joint face. There are two cutters on one head for roughing and semi-finishing the cylinder head joint face and three on the other for roughing and finishing the sump joint face. Each head is driven by its own 40 h.p. motor. Feed rates are variable between 20 and 60 in. per minute. A 0.125 in. roughing cut is taken.

4. Combined duplex milling machine. One head carries a 18½ in. dia. cutter with 50 teeth for finish milling the front and face of the cylinder block. At the other end is a planetary 2-spindle milling head for rough and finish milling the rear face.

ARCHDALE *SPECIALS*

for high production in the automobile industry

JAMES ARCHDALE & CO. LTD., LEDSAM STREET, BIRMINGHAM, ENGLAND

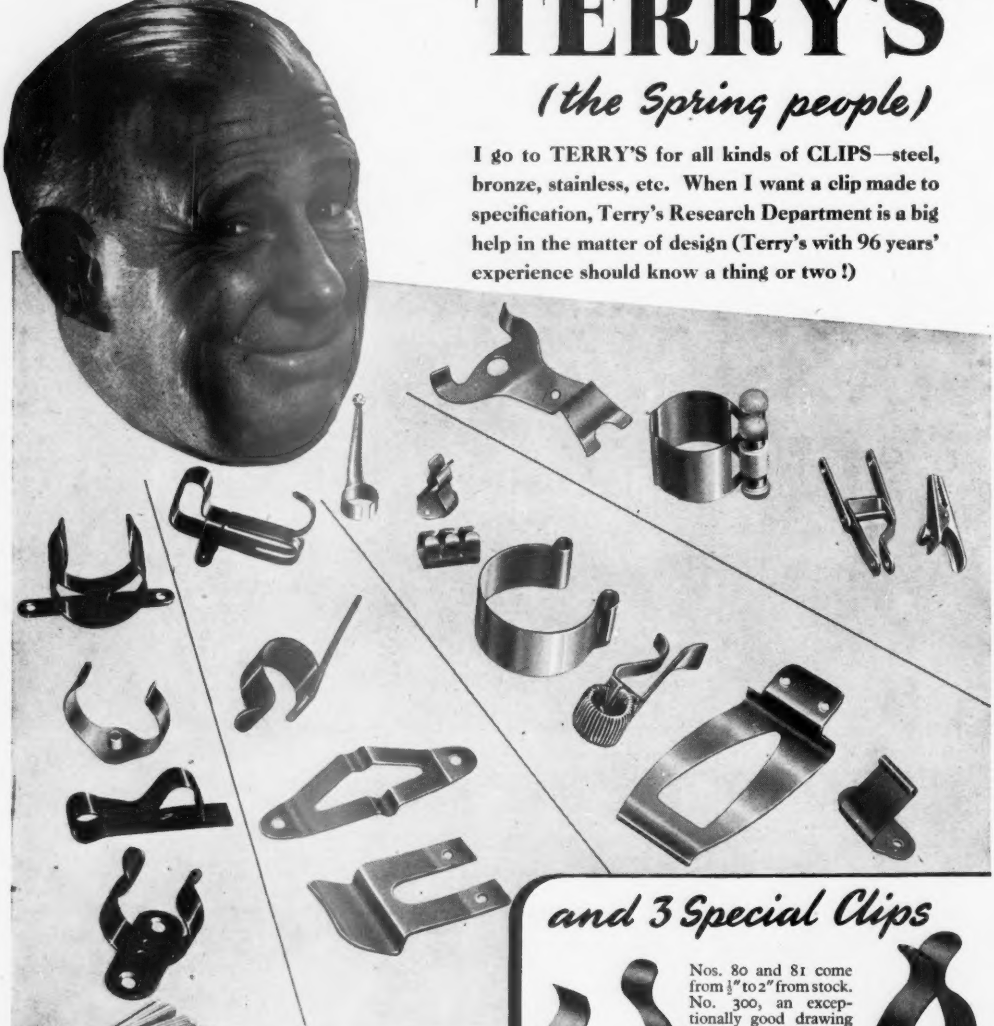
SOLE SELLING AGENTS: ALFRED HERBERT LTD., COVENTRY & BRANCHES

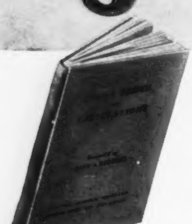
When *I* want a *CLIP* I turn to

TERRY'S

(the Spring people)

I go to TERRY'S for all kinds of CLIPS—steel, bronze, stainless, etc. When I want a clip made to specification, Terry's Research Department is a big help in the matter of design (Terry's with 96 years' experience should know a thing or two !)





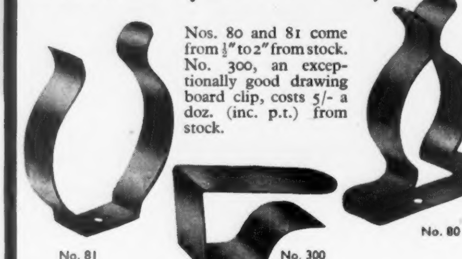
Want to know all about springs?

Here is the most comprehensive text - book on springs in existence.

Post free 12/6

and 3 Special Clips

Nos. 80 and 81 come from ½" to 2" from stock. No. 300, an exceptionally good drawing board clip, costs 5/- a doz. (inc. p.t.) from stock.

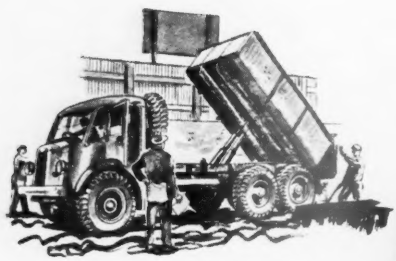


No. 81   No. 300   No. 80

Sole Makers : **HERBERT TERRY & SONS, LTD., REDDITCH** • London • Birmingham • Manchester

HT4F

Tipper efficiency?

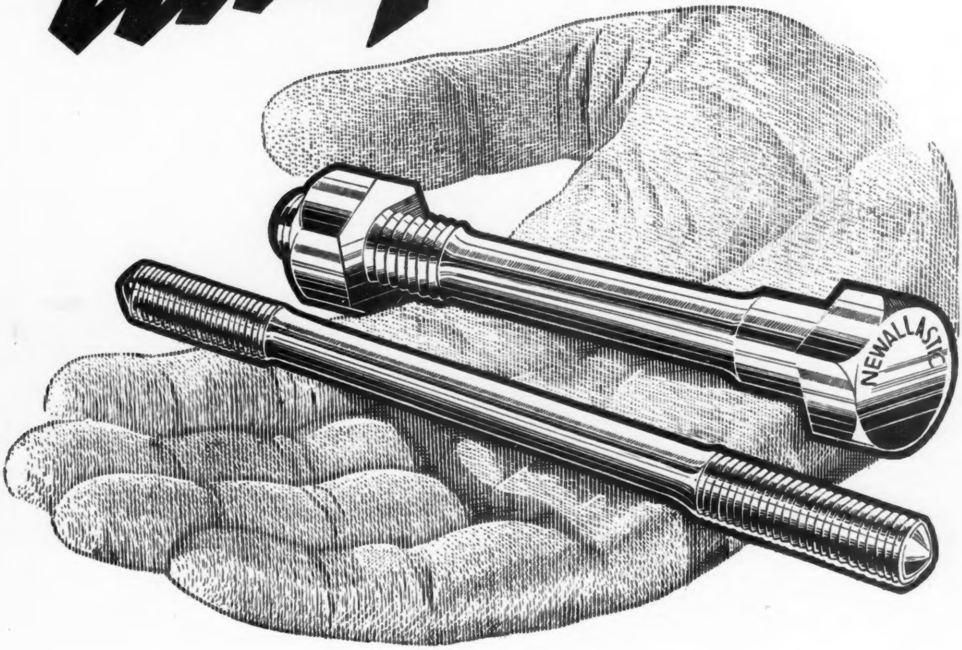


Dunlop Flexible Pipes put an end to pipe difficulties. Consider some of the practical advantages which they offer: durability and high fatigue-resistance, resulting from special Dunlop design and the traditional quality of materials and workmanship; short end-fittings that offer ease of installation; secure end-fittings that cannot be shifted by internal pressure. There are many types of coupling for original fitment or replacement, and, of course, high, medium, and low pressure ranges. The Dunlop Technical and Consultative Service is ready to advise you on all application problems.

IH 903

DUNLOP RUBBER CO. LTD., FOLESHILL, COVENTRY

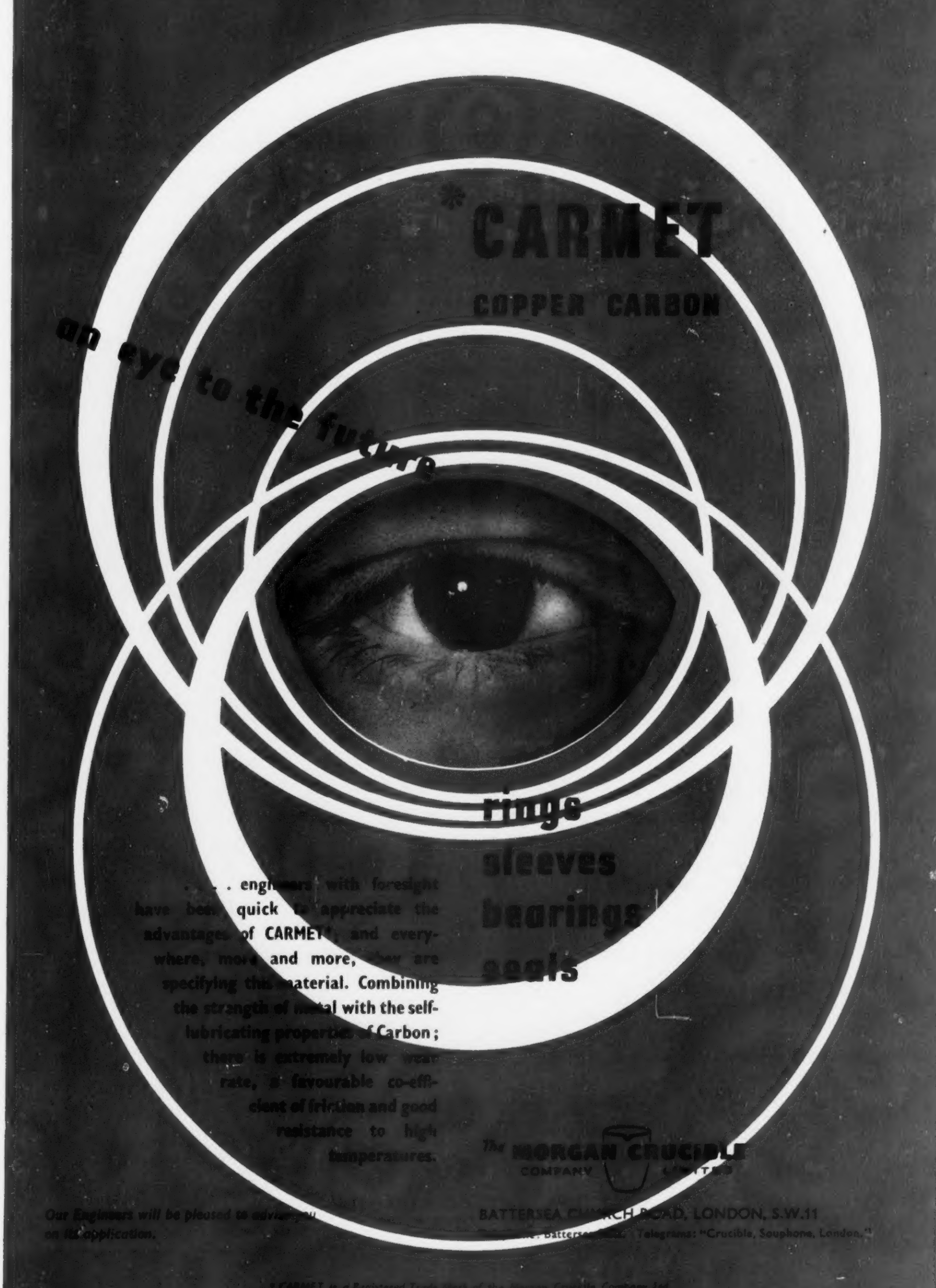
Unique

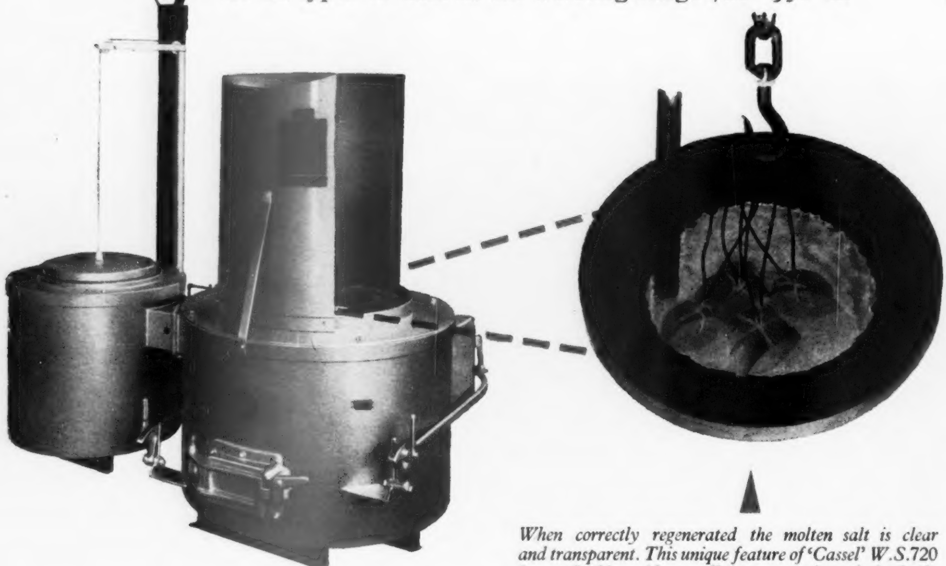


"Newallastic" bolts and studs have qualities which are absolutely unique. They have been tested by every known device, and have been proved to be stronger and more resistant to fatigue than bolts or studs made by the usual method

G. P. Newall & Co., Ltd.

POSSILPARK GLASGOW · N


*CARMET
COPPER CARBON
an eye to the future
rings
sleeves
bearings
seals
. . . . engineers with foresight have been quick to appreciate the advantages of CARMET*; and everywhere, more and more, they are specifying this material. Combining the strength of metal with the self-lubricating properties of Carbon; there is extremely low wear rate, a favourable co-efficient of friction and good resistance to high temperatures.
Our Engineers will be pleased to advise you on its application.
The MORGAN CRUCIBLE COMPANY LIMITED
BATTERSEA CHURCH ROAD, LONDON, S.W.11
Telegrams: "Crucible, Souphone, London."
* CARMET is a Registered Trade Mark of the Morgan Crucible Company Ltd.

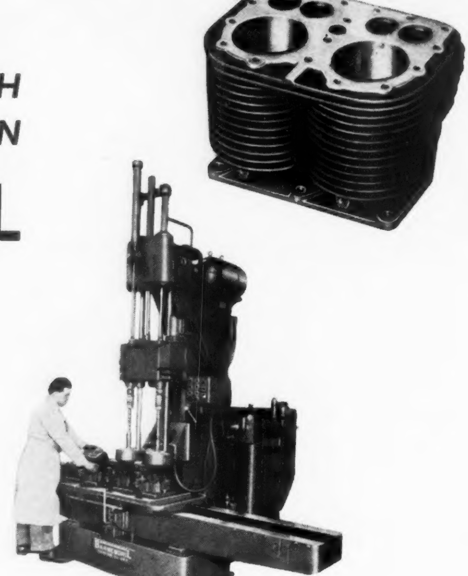


MARBAIX

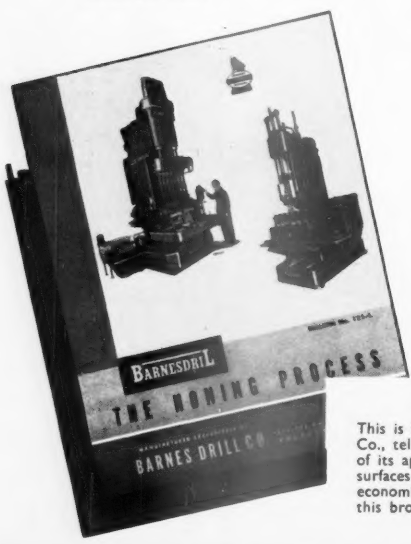
FOR UNUSUAL MACHINES

Get OUTPUT, FINISH and PRECISION *with* BARNESDRIL

SELF-OILING HYDRAULIC
HONING MACHINES



No. 307 BARNESDRIL honing machine, with 2-spindle auxiliary head and hydraulic lateral index table, for stock removing and finishing 2-cylinder motor blocks. Bore: 3¼" dia. × 6½" long. Stock removed ·005". Material: Cast iron. Production: 60 blocks per hour.



When you have production problems on any cylindrical surface requiring controlled accuracy and finish quality, hone on **BARNESDRIL** *Honing machines.*

Capacities range from fraction of an inch to 60in. dia. and 90ft. in length.

THE HONING PROCESS

This is the title of a brochure published by The Barnes Drill Co., telling of the development of the honing process and of its application for finishing cylindrical bores and exterior surfaces. If you are interested in improved finish and economical production, please write us for a free copy of this brochure.

Gaston E. Marbaix Ltd.

DEVONSHIRE HOUSE, VICARAGE CRESCENT, BATTERSEA, LONDON, S.W.11. PHONE: BATTERSEA 8888 (8 lines)

TOLEDO WOODHEAD

TOLEDO WOODHEAD SPRINGS LIMITED · SHEFFIELD 3

SUSPENSION ENGINEERS

TWS 42


When a job
needs **strength**
with lightness
and exactitude
PUT Aluminium FIRST
AND TI IN FRONT OF IT


The NEW Silentbloc FRUSTACON Mounting
This latest addition to the Silentbloc range has been designed to provide an engine mounting with a better performance at a lower price than any comparative type.
Of high load-carrying capacity and exceptional flexibility, the Frustacon has a range of deflection rates as wide as the engine designer could desire. The unusually large volume of rubber permitted by the Frustacon construction works in shear and compression. Compression pad (top) and rebound feature (bottom) are moulded in one piece.
The mounting is low in height, compact, easy to fit and readily accommodated in engine layouts.
with the right deflection for every load
Write for Technical Information
SILENTBLOC LTD
VICTORIA GARDENS, LADBROKE ROAD, LONDON, W.11. TEL. PARK 9821

Detachable oil filter

element easily inspected and replaced

This new AC partial-flow oil filter with replaceable element meets the increasing demand for a filter that can be removed for inspection and replaced every 8/10,000 miles. It provides a permanent installation for coupling into a by-pass oil supply system and the filtering element can be replaced without disturbing pipe connections. Sump oil is filtered on an average of ten times an hour. This means less motor wear and longer motor life — the objective of every motor manufacturer.

AC

AIR CLEANERS · AIR SILENCERS · CRANKCASE BREATHERS
CAR HEATERS · FUEL PUMPS · SPEEDOMETERS · GAUGES
INSTRUMENT PANELS · OIL FILTERS · THERMOSTATS
SPARK PLUGS · WINDSCREEN WIPERS · DIE CASTING

If you are contemplating an important new design, or a modification of an existing one, take advantage of the facilities of the AC Technical Bureau. We probably can save you hours of planning and experimentation. Write to the AC Technical Bureau, 54, The Butts, Coventry; or telephone Coventry 61747.

AC-SPHINX SPARK PLUG COMPANY,
DIVISION OF GENERAL MOTORS LTD.,
DUNSTABLE, BEDFORDSHIRE

FROM

THE "PIG"

TO THE PRODUCT

Lloyds High Duty Irons are under perpetual "quality control"

Although Lloyds castings are produced in large quantities, "quality control" is their constant taskmaster. Every batch of castings has a laboratory pedigree, all raw materials, and every heat, being under constant metallurgical control. Pig iron, scrap, alloys, coke and limestone are tested before reaching the cupola, whilst the charge is analysed every hour to ensure strict adherence to customer's specification. This complete scientific control gives castings a uniform structure, which ensures easy machining, exceptional durability and optimum efficiency. Write for a copy of "Iron Marches On".

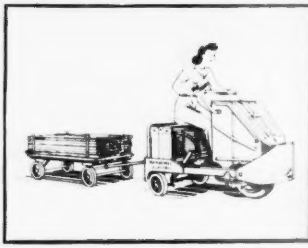
LLOYDS HIGH DUTY IRONS

LLOYDS (BURTON) LTD., WELLINGTON WORKS, BURTON-ON-TRENT   TELEPHONE: BURTON 3867

A Print for Industry Ltd Advertisement

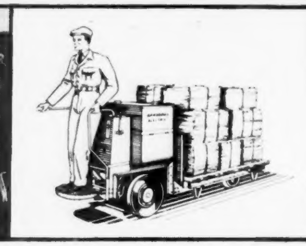

M&C TRADE MARK
YOU CAN'T GO WRONG
A challenge . . . but one that we can substantiate all along the line. Even today, our organisation is broad enough to cope with almost any 'small tools' order that you may care to send in. Monks & Crane, Britain's Foremost Distributors, take pride in serving you . . . promptly and efficiently. We still supply the goods.
MONKS & CRANE LTD
THE TWIST DRILL SPECIALISTS
Head Office:
STANHOPE STREET, BIRMINGHAM, 12
Telephone: CALthorpe 1381 (5 lines)
Telegrams: "Emancee, Birmingham"
London Office:
295, EUSTON RD., LONDON, N.W.1
Tel: Euston 5311 (3 lines)
Grams: "Emancee, London."
Manchester Office:
MANCHESTER OLD ROAD, RHODES, MANCHESTER
Tel: Middleton 3654 (3 lines)
Grams: "Emancee, Middleton, Manchester."

RANSOMES



20-30 cwt. Tractor with trailer.

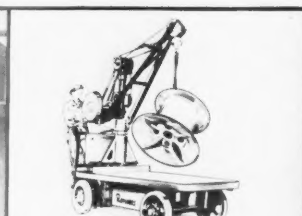
Forklift 20 handling forgings.



2 ton Truck with elevating platform.

make the Truck

1 ton Truck with fixed platform



Crane Truck — carries 1½ tons.
Lifts ½ ton loads.

Forklift 20 unloading rail trucks.

for the Job

No two factories are alike. Ransomes have been building Electric Battery Trucks to suit differing problems for 35 years — lifting, travelling, handling and negotiating confined spaces, with loads of all shapes, sizes and weights. Ransomes Electric Fork Trucks with their smooth, rapid lifting, turning and travelling are superb descendants of this long line of fine trucks and tractors.

Let our Technical Representative advise you on your interior transport problems.

RANSOMES SIMS & JEFFERIES LTD., ORWELL WORKS . IPSWICH . Phone: IPSWICH 2201 (6 Lines)

INDUCTION HEATING EQUIPMENT

Brings high speed flow-line production to soldering, brazing and heat treatment operations

COMPACT EQUIPMENT occupies minimum floor space.

INFINITELY VARIABLE POWER CONTROL by means of a single knob (7½ and 25 kw. units).

FULLY PROTECTED CIRCUITS with tell-tale indicator lights (7½ and 25 kw.).

AUTOMATIC SHUT-DOWN PROTECTION should water and air circulation become insufficient.

SILICA ENVELOPE VALVES, guaranteed for 1,500 working hours, can be repaired, reducing by 50% normal cost of valve replacement.

EASY SERVICING. Equipments are unit-built and factory-built replacements can be installed as sub-assemblies.

Output power: 25 kw. continuous, 35 kw. at 50% duty cycle with a maximum heating time of 8 seconds. Output frequency: 250-600 kcs. Power supply: Standard voltage 50/60 cycle, three phase, four wire. Power consumption: 50 kw. at full output, 4 kw. on standby. Power factor: 0·87 at full load.

25 KW.

TWO STATION SWITCH

Can be incorporated in any equipment, and speeds flow line production on many heating jobs. One station can be loaded whilst the heating cycle is in progress at the other and, if necessary, two dissimilar jobs can be treated on the same production run.

1 KW.

A compact unit suitable for numerous soft soldering, brazing and hardening applications. When delivering 1 kw. main loading is approx. 2 kw. with a power factor of approximately 0·9. Suitable for connection to 200/250 v. single phase, 50 cycle supply.

7½ KW.

Output power: 7½ kw. continuous. Higher output can be obtained for short duty cycles. Output frequency: two m/cs. Power supply: standard voltage 50 cycle, three phase, four wire. Power consumption: 15 kw. at full output, 600 watts at standby. Power factor: 0·9.

SPECIALISTS IN MECHANISED INDUCTION HEATING

APPLIED HIGH FREQUENCY LTD.

ACTARC WORKS, GOLDHAWK RD., LONDON, W.12

TELEPHONE: SHEPHERDS BUSH 1151

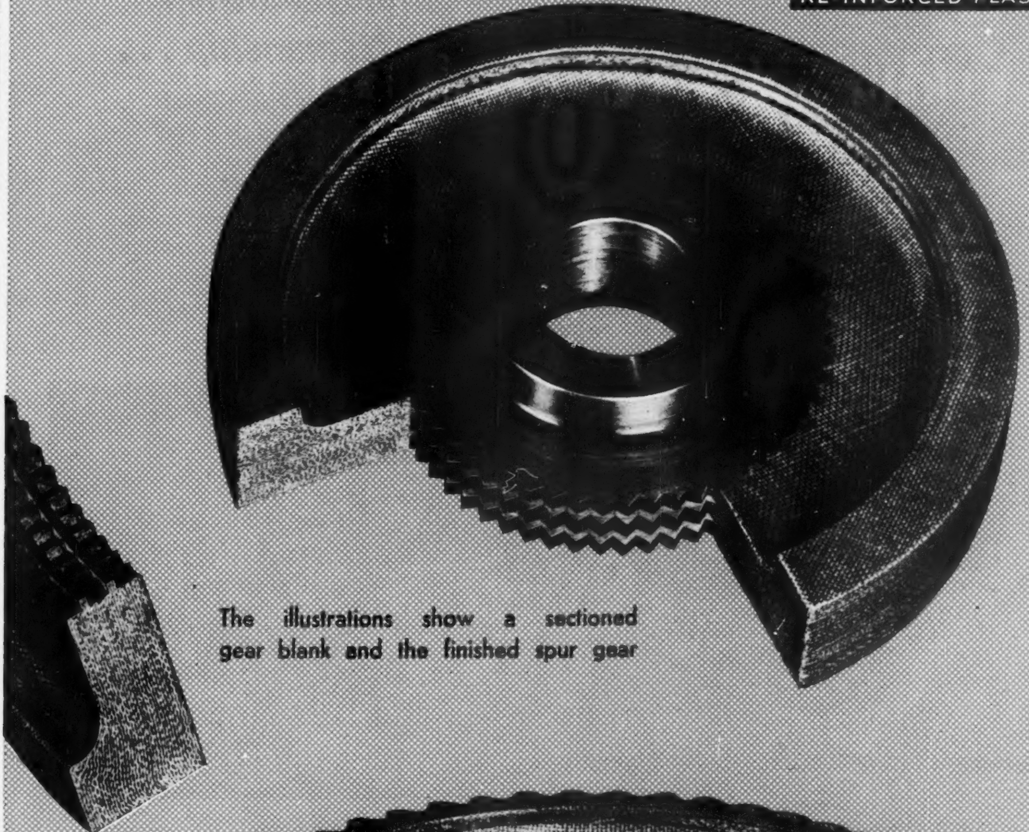
140 FI

CLEVELAND
GUARANTEED
CLEVECOL
SERVICE TELLS
"My experience confirms their claim of prompt and attentive service"
says Mr. User.
NORTHSIDE SERVICE REPAIRS & PETROL STATION
CLEVELAND
CLEVECOL
KEEP LEFT
J. CANNING

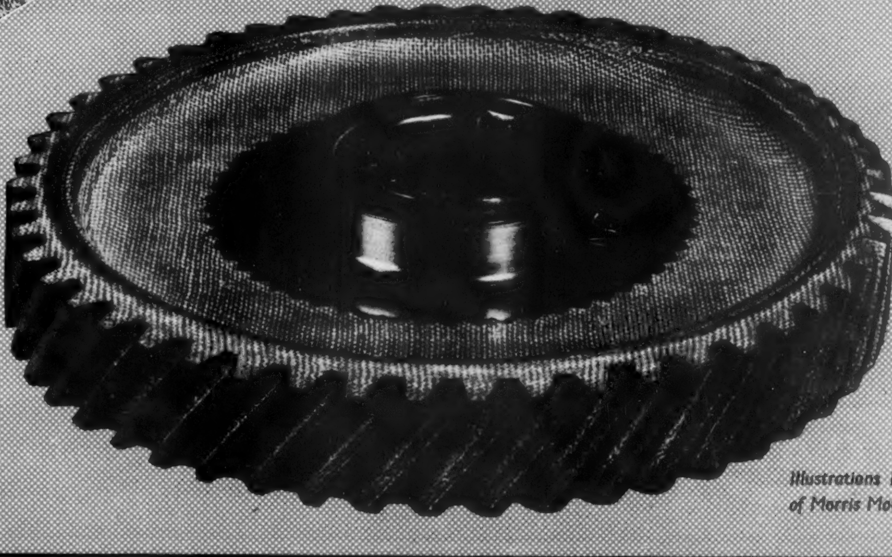
RE-INFORCED MOULDINGS

better in TEXOLEX

RE-INFORCED PLASTICS



The illustrations show a sectioned gear blank and the finished spur gear



Illustrations by courtesy of Morris Motors Limited

THE BUSHING CO. LTD., HEBBURN-ON-TYNE

Research . . .
Development . . .
Craftsmanship . . .

C.A.V. Fuel Injection Equipment is backed by intensive work in some of the finest laboratories in the country, comprising physical, metallurgical, X-ray and fuel injection development divisions, engine dynamometer test beds, humidity and low temperature test rooms as well as sections devoted to basic research.

In the production of the elements of C.A.V. Fuel Injection Pumps, the workmanship represents what is probably the highest standard attained in any branch of precision engineering. Clearance between a pump barrel and its plunger is approximately 1 micron (0.00004 in.), whilst the surface of plungers is finished by hand lapping to within 1.5 micro-inches (1 micro-inch is one millionth of an inch).

C.A.V.

Fuel Injection and Electrical Equipment

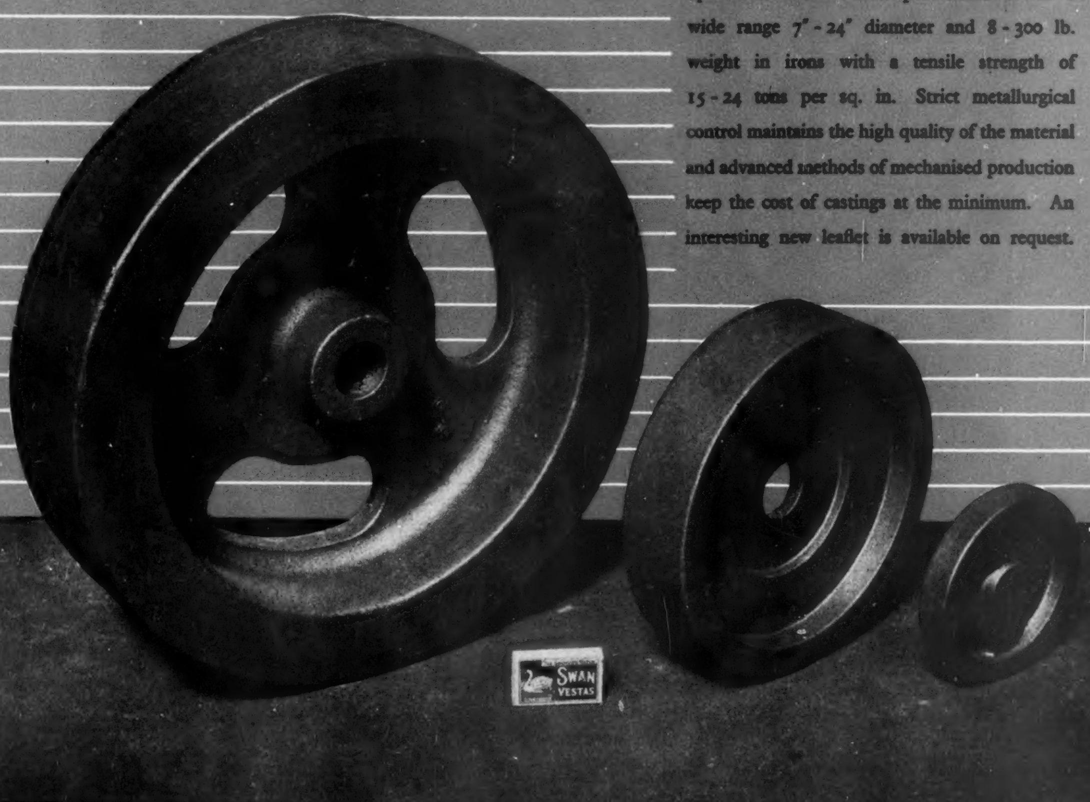
C. A. V. LIMITED, ACTON, LONDON, W. 3

FLYWHEELS
IN CAST IRON

by

DARCAST

Exhaustive tests at high speeds and production and use over a long period have proved the suitability of Darcast Flywheels in high duty cast iron for petrol and diesel engines and for compressors. Long specialised experience ensures homogeneity in the castings which is necessary to obtain uniform density with perfect balance, while the machining faces are free from hot-crazing and suitable for friction clutch operation. Our current production covers a wide range 7″ - 24″ diameter and 8 - 300 lb. weight in irons with a tensile strength of 15 - 24 tons per sq. in. Strict metallurgical control maintains the high quality of the material and advanced methods of mechanised production keep the cost of castings at the minimum. An interesting new leaflet is available on request.



DARTMOUTH AUTO CASTINGS LIMITED
SMETHWICK 40 BIRMINGHAM


MAAG
GEAR CUTTING MACHINES
MAAG Gear Cutting Machines incorporate the latest developments in gear cutting technique in addition to the essential features and refinements associated with MAAG design emanant from over thirty years pioneer experience in the manufacture of precision gears and gear production equipment.
Whilst the demand for economical production is fulfilled, no principle has been spared which will ensure extreme accuracy of product and ease of operation of machine.
The MAAG range comprises machines for high rate cutting of spur and helical gears from 0.8" to 200" diameter with pitch and profile errors to ground gear limits.
Illustrated is the SH-150/180 machine for cutting gears from 7" to 70" diameter.
Full details on request.
NOW OBTAINABLE WITHOUT IMPORT LICENCE
SOLE AGENTS IN GREAT BRITAIN
BURTON, GRIFFITHS & Co. Ltd.,
MARSTON GREEN, BIRMINGHAM

AUTOMOBILE ENGINEER

Design, Materials, Production Methods, and Works Equipment

Consultant: W. L. FISHER, M.I.Mech.E., M.S.A.E.

Editorial Staff: R. T. CARR, M.Sc., A.M.Inst.C.E., A.M.I.Mech.E., J. B. DUNCAN, T. K. GARRETT, A.M.I.Mech.E., A.F.R. Ae.S., F. C. SHEFFIELD

Publishers: ILIFFE & SONS LTD., DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1.
Telegrams: Sliderule, Sedist London **Telephone: Waterloo 3333 (60 lines)**

COVENTRY:	BIRMINGHAM, 2:	MANCHESTER, 3:	GLASGOW, C.2:
8-10 CORPORATION ST.	KING EDWARD HOUSE, NEW ST.	260, DEANSGATE	26B, RENFIELD ST.
Telegrams: Autocar, Coventry	*Telegrams:* Autopress, Birmingham	*Telegrams:* Iliffe, Manchester	*Telegrams:* Iliffe, Glasgow
Telephone: Coventry 5210	*Telephone:* Midland 7191-7	*Telephone:* Blackfriars 4412	*Telephone:* Central 1265-1266 (2 lines)

PUBLISHED MONTHLY—SECOND THURSDAY

Annual Subscription: Home and Overseas £2 11s. 6d., including the Special Number; Canada $7.50; U.S.A. $8.00

VOL. XLII No. 550 FEBRUARY 1952 PRICE 3s. 6d.

Shock Absorbers

EULOGIES on the early motor cars are still frequently heard and the reasons for these are probably as much psychological as mechanical. Few experienced motorists, however, would wish to revert to the regular use of these vehicles to-day. More by chance than by design, some early chassis embodied a happy combination of weight distribution, springing, frame design, castor action, and roll characteristics that gave quite exceptionally good results in road holding and steering. It has to be borne in mind, however, that only in exceptional instances were speeds comparable with those prevailing today.

Despite the advances that have been made, a very great deal still remains to be done in the matter of suspension and the allied features of steering and road holding. Current standards of comfort are high, and the evolution of the low-pressure tyre, together with independent front suspension, greatly complicates the whole problem. The factors within the vehicle itself are now so many and so varied in their influence. There is the independent system of springing itself, whether coil, torsion bar or leaf, tyre pressures, shock absorbers, anti-roll bar, and weight distribution.

Within the range of these interactions lie seemingly endless combinations and permutations, even with relatively narrow variations of vehicle speed and road irregularity. Added to this, the potentialities of much increased speeds, varying overall weights, and even types of steering must be considered, to say nothing of roll centre, roll angle, centre of mass and slip angle. That no completely satisfactory solution has yet been reached is not surprising.

Present Requirements

The designer's objective, of course, is to provide a suspension that will give a safe and comfortable ride over a likely range of speeds. Although the road surface can, fortunately, be largely forgotten in most of the so-called civilised countries, provision must be made, nevertheless to meet in some measure the conditions prevailing where less progress has been made. In addition to a comfortable ride, customers now demand good directional stability and cornering control in the matter of steering, with adequate reserve of anti-roll to counteract the effects of the sharper bends and emergency manoeuvres.

At the moment, the accent is definitely on comfort, and the low pressure tyre is relied upon to make too large a contribution to this. It would appear, therefore, that still more responsibility will have to be passed on to the designers of shock absorbers. To suggest a component designed individually to meet the needs of each suspension system would be a counsel of perfection, but at least one that is more readily adjustable to the requirements of the vehicle, and even of the user, could be provided.

As at present, it should stiffen up the suspension against roll. Additionally, it should relieve the tyre of some of the work of smoothing out the smaller pot-holes and irregularities. A minimum of resistance should be offered at the first inch or two of movement, particularly at low accelerations. When, however, pot-holes and irregularities demanding larger amplitudes are encountered, a progressive stiffening of the system is evidently necessary. Slightly higher tyre pressures could then be employed to improve lateral rigidity.

Progressive Action

This seems to imply that the shock absorber needs to be more progressively sensitive to accelerations. Considerably more account needs to be taken of the time factor. When small obstacles such as ripple surface and cat's-eyes are encountered, these should be absorbed more readily at lower accelerations than at high, and without making such large calls upon the tyre.

In the matter of anti-roll and its effect upon steering, some suspension layouts are much more sensitive to tyre pressures than others. They all, however, appear to be unduly sensitive to rear suspension stiffness. When this is excessive, too much roll is taken at the rear tyres, thus upsetting the roll angle and introducing an oversteer that can be highly disconcerting on the straight, particularly at the higher speeds. In such conditions, continual correction is necessary to keep the vehicle on a straight course. Further, such vehicles are particularly liable to skidding.

A different set of problems arise with rear swing-axle layouts, and the foregoing notes, of course, refer to the more general independent front springing with orthodox rear axle. Much, however, remains to be done, but it is to be hoped that rather less than more will be expected of the tyre.

In short, if progress is to be made, the shock absorber will have to be something more than a simple damper. It will be necessary to supply more of the suspension characteristics than any spring system, by its very nature, is able to provide. The tyre should be required to act

merely as a first insulator. At present it is relied upon for too large a part and consequently all modern cars are super-sensitive to tyre pressures. It would seem that it is in the shifting of some of the burden that progress will probably lie.

Jubilee Year

MOST inauspiciously, a complexity of problems besets the motor industry in this its jubilee year. The Society of Motor Manufacturers and Traders, formed in 1902, had to meet and overcome many obstacles in the early years of its existence but its record has been one of steady progress and development. To-day, the industry holds a prominent place in British economy and is our greatest exporter. Last year cars and commercial vehicles were coming off the production lines at the rate of 2,800 each working day, though that represented a reduction of almost six per cent from the figure for the previous year. Shortages in the supply of certain materials, notably steel, were beginning to affect production rates. Nevertheless, exports of cars, commercial vehicles, agricultural tractors, parts and accessories were maintained at the approximate total value of £293 million.

Competitive Position

In view of the country's desperate need to increase exports, it is ironic that the industry is now subjected to rationing and reduction of supplies. Mounting costs of production, heavy taxation, the curb on capital investment, shortage of machine tools, and associated reasons all hamper the industry's efforts and weaken its competitive position. The home market, limited last year to 110,000 cars and 100,000 commercial vehicles, has been cut to 60,000 in each category.

Over all is the shadow of the vast rearmament programme. This will, of necessity, divert plant, tools, labour, materials and finance from normal production. To these difficulties must be added the impact of deflation policies on incomes and standards of living, both at home and abroad. The car-owning strata of the population is hardly likely to be extended; it may be reduced. Small wonder, then, that manufacturers are giving some thought to the miniature car or the economy car. High hopes have been expressed that the fully equipped miniature car may meet the needs of the situation and even tap a new strata of the population by virtue of its relatively economical running. Its first cost, however, would seem to be a handicap.

Even in the highly sophisticated European countries, the true "economy" car appears to be slowly establishing itself. In some of the Asian and Pacific countries it would seem to be the only type that could be offered at a price the inhabitants could afford. The rapid reaction of the Japanese motor industry is an indication. At the termination of hostilities, it had no hope of competing in world markets and was almost wholly occupied in replacing the neglected civilian needs of its own country. Then came the fillip of the war in Korea which, admittedly, "saved the situation". Orders for thousands of vehicles were received, plants were renovated and expanded, and a minor boom followed. However, although production of standard-sized cars has been raised as a result of this re-equipment of plants, it is recognized that it cannot be maintained by domestic demand, and overseas competition cannot be contemplated in view of the high cost of materials. Accordingly, a remarkable development of so-called midget cars and three-wheelers has occurred. These small vehicles are popular in Japan and also in South-East Asian countries on account of their low initial price and low rate of fuel consumption. The production of three-wheelers, for example, has jumped from 3,827 in 1946 to 37,584 in 1950. The Japanese, apparently, are beginning to tap a market we have hardly deigned to consider as yet.

Future Outlook

When the rearmament programme is completed, in two or three years' time, supplies will be easier and production can again be raised. A brisk temporary demand, to cover replacements postponed during the lean years, can be foreseen. With ample material, labour and production facilities, this will soon be met and we must then expect fiercer competition in world markets. All manufacturing countries will be in a similar position, American production resources are enormous and some European countries have used American aid to build and equip completely up-to-date plants.

British vehicles, no doubt, will stand on their quality, but price will be of paramount importance. We should be prepared to make a drive in new markets and for new potential customers.

CONTENTS

THE DAIMLER REGENCY

A 3-litre Chassis for a Six-seater Vehicle of Modern Style

THE principal aims in the design of the Daimler Regency have been to provide adequate comfort for long journeys, and absolute mechanical reliability for at least 50,000 miles before any question of overhaul arises. At the same time, its road-holding characteristics and performance enable fairly good average speeds to be maintained. The car is not outstanding as far as acceleration is concerned, but it has a relatively low fuel consumption for its size.

To satisfy current demands, particularly from overseas, several new features have been introduced into the layout of the Regency, as compared with that of the older Consort. One of these innovations is the modern styling which helps to provide ample width for seating three abreast. Further, improvement in the rear seat arrangement has been effected by moving the whole body forward some 6 in. Not only has this measure taken the rear seats forward of the wheel-arches, but it has also increased the capacity of the luggage boot. The forward positioning of the body has, of necessity, involved moving the engine forward. This has increased the front overhang and, to balance this, the rear overhang has been similarly extended, resulting in further improvement in boot capacity. The engine is set at an angle of 5 deg so that only a small pressed steel cover is needed on the floor over the gear box. Apart from this, by virtue of the incorporation of a propeller shaft intermediate bearing and a hypoid rear axle, the floor is unobstructed.

SPECIFICATION

ENGINE: Six cylinders. Bore and stroke 3 in × 4¼ in. Swept volume 2,952 cm³. Maximum b.h.p. 90 at 4,100 r.p.m. Maximum b.m.e.p. and torque 124 lb/in² and 148 lb-ft at 1,600 r.p.m. Compression ratio 6·7:1. Four-bearing forged crankshaft. Push-rod operated overhead valves. Two carburettors S.U. type H4, horizontal.
TRANSMISSION: Daimler fluid flywheel with epicyclic pre-selective gearbox. Ratios: top 1:1, third 1·56:1, second 2·32:1, first 4·108:1, reverse 5·4:1. Hardy Spicer propeller shaft with centre bearing.
REAR AXLE: Hypoid bevel. Ratio 4·3:1.
FRONT SUSPENSION: Independent, coil spring, Girling type.
REAR SUSPENSION: Semi-elliptic.
SHOCK ABSORBERS Newton telescopic front and rear.
STEERING: Marles cam-and-roller.
BRAKES: Girling hydro-mechanical 12 in diameter × 2¼ in wide.
TYRES: 6.50 × 16.00
DIMENSIONS: Wheelbase 9 ft 6 in. Track, front 4 ft 8 in, rear 4 ft 9 in.
MATERIAL SPECIFICATION: Owing to the current supply position, specifications quoted in the article are in many cases substitutes and are liable to further change.

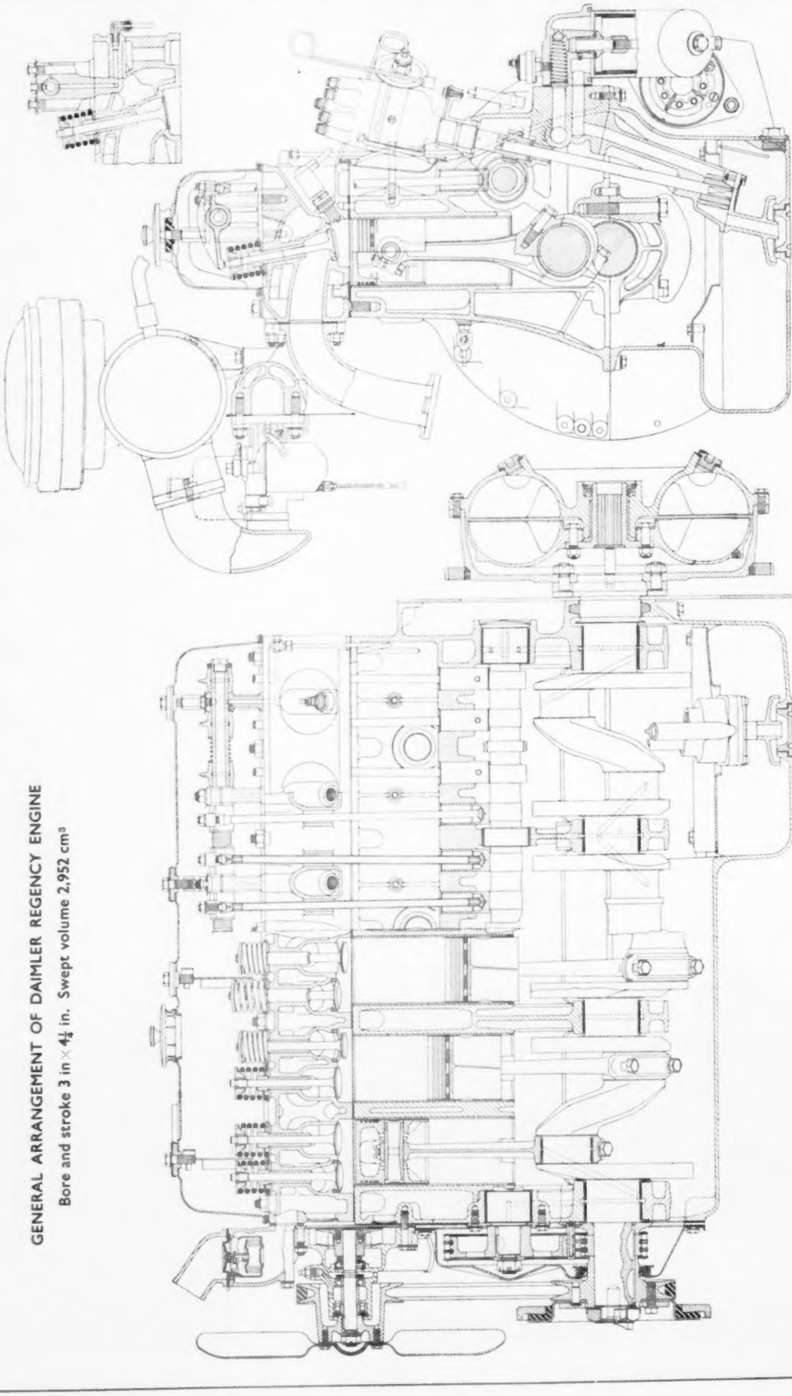
In order to seat three abreast, it has been necessary to increase the track, as compared with the Consort, from 4 ft 4 in front and rear to 4 ft 8 in front and 4 ft 9 in rear. Whilst the wheelbase has remained at 9 ft 6 in, the frame has had to be extended at the front and rear ends to accommodate the longer body. All these measures have inevitably increased the weight of the vehicle as well as its load-carrying capacity, and in consequence 6.50 × 16.00 tyres have been specified and the engine capacity has been raised from 2½ litres to 3 litres.

Even with these increases, the engine might be regarded as small considering the weight and size of the car. However, this choice of engine capacity was made deliberately with a view to obtaining an economical rate of fuel consumption. Figures for the weight of the vehicle are not given here, as no production car is available and it would be misleading to quote the weight of an experimental car.

Engine

The 6-cylinder engine has a bore and stroke of 3 in × 4¼ in giving a swept volume of 2,952 cm³, and the compression ratio is 6·7 : 1. The maximum torque is 148 lb-ft at 1,600 r.p.m., corresponding to a maximum b.m.e.p. of 124 lb/in². This is a low speed at which to develop maximum torque, but it is a feature needed in order that full advantage may be taken of the fluid flywheel characteristics and to

Modern lines give adequate room for six adults in the Daimler Regency



GENERAL ARRANGEMENT OF DAIMLER REGENCY ENGINE

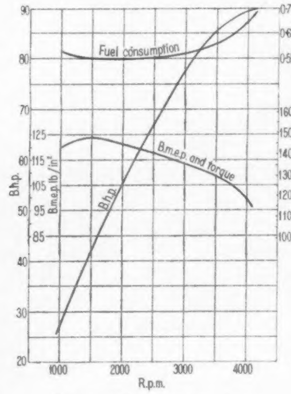
Bore and stroke 3 in × $4\frac{1}{4}$ in. Swept volume 2,952 cm^3

get away briskly from a standing start. The peak power of 90 b.h.p. is developed at 4,100 r.p.m.

The general layout of the engine is fairly conventional. Externally, nearly all the auxiliaries are on the left. On this side the generator is mounted on top of a bracket bolted to the crankcase at the front and adjacent to the cylinder block. The starter motor is mounted on the same side, low down on the rear plate and the bell-housing flange, alongside the sump. Immediately above this, and bolted to the crankcase, is the full-flow oil filter, inclined so that the lower part of its casing clears the front end of the starter. On the crankcase above the fitler is the contact breaker and distributor. The diaphragm-type fuel pump, with its integral bowl-filter, is positioned approximately at the centre of the crankcase wall. Above the fuel pump, on the side of the cylinder block but below the sparking plugs, is bolted the ignition coil.

The other side of the engine is clear except for the two S.U. horizontal carburettors and the inlet and exhaust manifolds. At the front, the usual triangulated V-belt drive from the crankshaft is used for the fan and coolant pump at the top of the block and for the generator. At the rear, the Daimler fluid flywheel and change-speed box are incorporated instead of the more widely used flywheel, clutch and gearbox arrangement.

The cast-iron cylinder block and crankcase incorporates cooling passages around each of the six cylinders. These are well spaced to facilitate core-making and casting, the minimum passage width between them being $\frac{7}{32}$ in. Dry liners of Hepworth and Grandage Vacrit, or Brico Brivadium, are pressed into the cylinder bores, the interference fit being their only location. They are machined with a



Engine performance curves

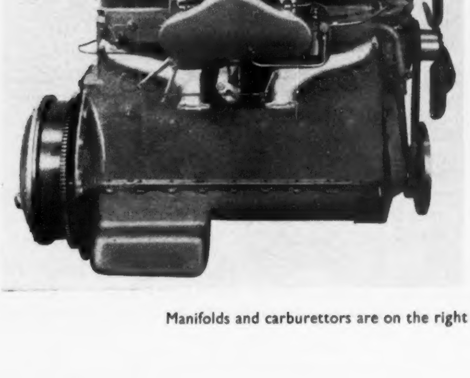
single point tool and are hone-finished. The crankcase webs supporting the four crankshaft bearings also carry the four bearings for the camshaft situated on the left-hand side.

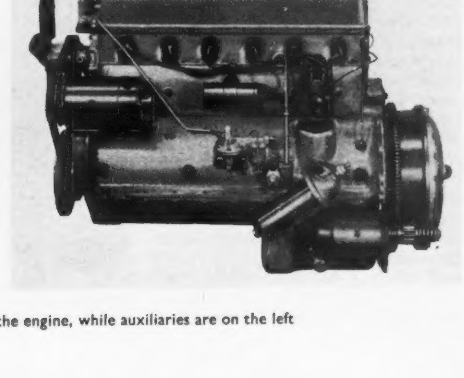
A Walker's Gascoid washer is used to make an oiltight joint on each side of the front engine-plate which carries the usual inclined sandwich-rubber engine mountings. Oil leaks due to malalignment of the front face of the sump and crankcase are avoided by dowel-locating these two components. The rear end of the crankcase and sump is completely enclosed, so that the rear engine-plate serves only to support and close the bell housing.

The crankcase walls extend down to the level of the crankshaft centre line, and adequate ribbing supports the four main journal bearing webs. Bearing caps of semi-steel 786 Grade 2, are located by En 8 Q dowels, and secured by En 16 R set-bolts locked by tab washers. Vandervell D2 Bimetal bearings with S.A.E. 1010 steel backs are fitted. Projections pressed out at the abutting faces on each half of the shells engage in slots in the cap and bearing housing to provide for locating in the usual manner. All the journals are $2\frac{1}{2}$ in diameter, the bearing lengths being: $1\frac{3}{4}$ in front, 2 in rear, and $1\frac{1}{2}$ in for the two intermediate ones.

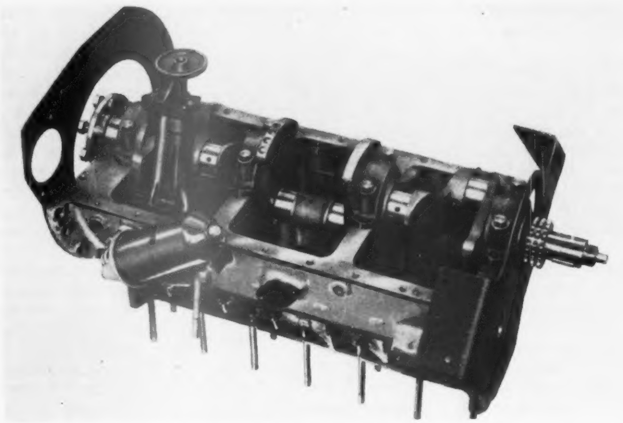
Weights formed integrally on the webs of the forged crankshaft give both static and dynamic balance. Semicircular Vandervell D2 Bimetal thrust washers are fitted, one each side of the front bearing cap. The inner one bears against the crank web, and the outer one against an En 15 R thrust ring on the $1\frac{3}{4}$ in diameter front extension of the crankshaft. With this simple arrangement two half-washers are used instead of the more usual four, and only the bearing caps have to be machined to house them. Furthermore, they are self-locating against the bearing housings.

At the rear of the crankshaft an integral thrower ring and a felt seal are the only oil retaining devices. Behind these is a flange for the fluid flywheel. At the front of the crankshaft, the extension carries, in addition to the thrust ring already mentioned, an En 15 R sprocket for the three-row timing chain, and the En 8 Q fan-belt pulley. The whole assembly is pulled up against the shoulder at the front main bearing by the front nut incorporating the starting dogs and locked by a tab washer. Two Woodruff keys furnish the drive. The rearward-extending boss on the fan-belt pulley forms the bearing surface for the lip-type oil seal housed in the pressed steel timing cover. To the front of the fan-belt pulley a Metalastik torsional vibration damper is dowelled and bolted. Rubber is sandwiched between its inertia ring and the pressed steel hub, the junction being made by a rubber-to-metal bond.





Manifolds and carburettors are on the right of the engine, while auxiliaries are on the left



Crankcase walls extend only to the level of the crankshaft axis

The H-section connecting rods of En 15 R have a centre-to-centre length of 8 in. Their big ends are split at an angle of 52 deg to the horizontal so that the rods may be removed through the liner bores. Set-bolts of En 25 T, locked by tab washers, secure the caps. Location is by means of short dowel tubes, of En 8 Q, around the bolts at the abutting faces of the caps and rods. Vandervell D2 Bimetal big-end bearing shells are fitted, having an effective length of 1 $\frac{1}{16}$ in on 2$\frac{1}{4}$ in diameter crank pins. They are located in the same manner as the main journal bearing shells. At the small end, an En 25 T pinch-bolt secures and locates the $\frac{7}{8}$ in diameter TS 14, carburized gudgeon pin.

Wellworthy 52 alloy pistons are employed. Heat-flow from the crown to the skirt is partially restricted by horizontal slots, on each side of the piston, just below the scraper ring. On the side opposite the thrust face, a split in the skirt, inclined slightly from the vertical, joins one of the horizontal slots at its centre to allow for expansion. Vertical drillings in the piston bosses assist the lubrication of the gudgeon pin bearings. Three Wellworthy compression rings and one scraper ring, all of heat-treated D.T.D. 485, are fitted. The compression rings are 0·0625 in wide × 0·1185 in radial thickness, and the slotted scraper ring is 0·1875 in wide × 0·1105 in radial thickness.

An unusually sturdy SB 230-2, Keyston brand camshaft, 1 $\frac{13}{32}$ in diameter, is carried in four Vandervell white-metal lined thin wall bearings pressed in bosses in the crankcase webs. All the bearings are 2 in diameter, the respective lengths being: rear 1 $\frac{5}{8}$ in, centre pair $\frac{13}{16}$ in, and front 1 $\frac{7}{16}$ in. Had a lighter camshaft been fitted, the good lift-characteristics obtained from careful design of the non-surge cam profiles, would have been nullified by undue deflection. The trailing flank of the cam differs from the more complex leading flank in that it is of simple harmonic design.

At the rear, the usual Welch plug is used to blank off the outer end of the bearing. Hydraulic locking, on assembly, is prevented by an eccentrically positioned longitudinal drilling that communicates between the rear end face of the shaft and the forward face of the shoulder forming the rear bearing. On a 1 in diameter extension at the front an En 15 R half-speed wheel, driven by a Woodruff key, is secured by a split-pinned, slotted nut and thick washer. Clamped between the rear of the timing wheel boss and a shoulder on the shaft is a steel thrust washer. End location of the camshaft is effected by a plate around the shoulder between this washer and the front bearing. The assembly comprising the camshaft, half-speed wheel, thrust washer, and locating plate, is fitted to the crankcase to which the locating plate is then secured by four set-bolts and spring washers, a box spanner being passed through holes in the half-speed wheel to tighten the set-bolts.

At the centre of the camshaft is the fuel pump drive eccentric, while the skew gear, driving the oil pump and ignition distributor, is formed integrally with the camshaft between numbers 3 and 4 bearings. The gear with which it meshes, made of Holroyd's Spuncast Holfos bronze grade J.H. 17 or B.S.S. 2 B 8, is keyed on the upper end of the gear pump drive spindle which is inclined in a transverse plane at an angle of about 12 deg from the vertical. In the upper face of the gear boss is a slot to receive the tongued end of the driving sleeve pinned to the spindle of the contact breaker and distributor. The lower face of the gear boss bears on a hardened En 32 A steel thrust washer, supported on the flange of a bush of N.P.C. sintered, high duty bronze, mounted, flange uppermost, in a boss on the crankcase wall. In this bush runs the upper end of the oil pump driving spindle which is additionally supported, at its lower end, in the cast iron pump casing.

The sides of the 1 in diameter piston-type tappets made of chilled cast iron, are drilled near the base to allow oil that runs down the push rods to drain away to the sump. They are carried in bosses in the crankcase. Access to them is gained by removing a pressed steel tappet cover secured to the side of the block by six set-screws. An oil-tight joint is ensured by the use of a cork washer.

Tubular pushrods of A4 0·33 per cent carbon steel are employed. Cyanide hardened En 32 A ball and cup-ends are inserted at their lower, and upper extremities respectively, the effective length of the assembly being 12 in. In the En 32 A rockers, screwed ball-ends fitted with locknuts seat in the cup ends of the push rods, and provide for tappet clearance adjustment in the usual manner. At the other ends of the rockers, cyanide hardened pads bear on the valve stems, and at the centre of each rocker a carburized bore forms the bearing surface.

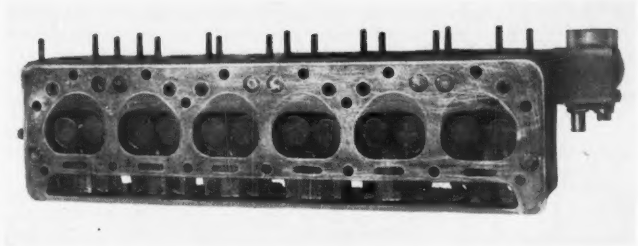
Pedestal bearings between each pair of rockers carry the hollow rocker spindle, $\frac{13}{16}$ in diameter × $\frac{3}{16}$ in thick, made of carburized En 32 A. Two tab-washered studs and nuts secure each bearing cap and pedestal on the cylinder head. Around the spindle, compression springs with end thrust washers are provided between the rockers, constraining them to bear against their pedestals. The front and rear rockers are each constrained by a Belleville spring between two plain steel washers secured by a split-pin through the shaft. Thimbles made of normalized A3 steel are pressed in the ends of the spindle to retain the lubricating oil.

The inlet valves are of Jessops H3, hardened steel, and they seat on faces cut in the cylinder head. On the other hand, the exhaust valves are of Jessops H29, XB steel, used in conjunction with Brimochrome, Durachrome, or Wellworthy Valmet seats pressed into the cylinder head. Although the XB valve steel, unlike the austenitic steels, has a comparatively

low coefficient of expansion, it is still considered necessary to taper the valve stems towards the head for a distance of about 1 in inside the guide. The principal dimensions are: inlet valve head diameter $1\frac{9}{16}$ in, throat diameter $1\frac{7}{16}$ in, stem diameter $\frac{3}{8}$ in, lift $\frac{3}{8}$ in; exhaust valve head diameter $1\frac{3}{8}$ in, throat diameter $1\frac{1}{8}$ in, stem diameter $\frac{3}{8}$ in, lift $\frac{11}{32}$ in.

Valve springs of $1\frac{1}{2}$ in outside diameter are employed, thus keeping down the overall height of the engine. They are held by Bul-lock split cotters, and at their base they bear upon pressed steel washers held in position under flanges formed on the top of the pressed-in cast iron guides. In the exhaust port, little obstruction to the gas flow is offered by the guide, the lower end of which is almost flush with the port wall. This arrangement has resulted in the incorporation of maximum cooling area around the guide in the cylinder head. The inlet guide, on the other hand, extends into the larger diameter inlet port, a distance of about $\frac{5}{8}$ in. Both guides are $2\frac{1}{2}$ in long, and are set at an angle of about 10 deg from the vertical in transverse planes. The tappet clearances, with the engine warm, are 0·013 in at the valve, but in practice it is found that there is very little difference between the hot and cold clearances. A ramp is incorporated on the leading portion of the cam profile to take up the clearance quietly. There is a 36 deg overlap in the valve timing which is: inlet opens 13 deg before T.D.C. and closes 56 deg after B.D.C., exhaust opens 46 deg before B.D.C. and closes 23 deg after T.D.C.

The cast iron cylinder head is deep enough to provide room for very generous cooling passages, particularly around the valve ports and sparking plug bosses. These bosses are well recessed so that the upper ends of the screened plugs, set at an angle of about 35 deg to the horizontal, do not project out beyond the jacket wall of the cylinder head. Coolant is directed on to the valve seats by thimble-shaped jets pressed into the lower face of the head. Ducts immediately below the sparking plug bosses ensure that they are adequately cooled. From the pump mounted high on the front end of the cylinder block, the coolant is circulated around the upper part of the cylinder walls, through these jets and ducts into the head, and thence out past the thermostatic valve in its D.T.D. 424 housing. An incidental thermo-syphon circulation furnishes all the cooling needed at the lower part of the cylinder walls.

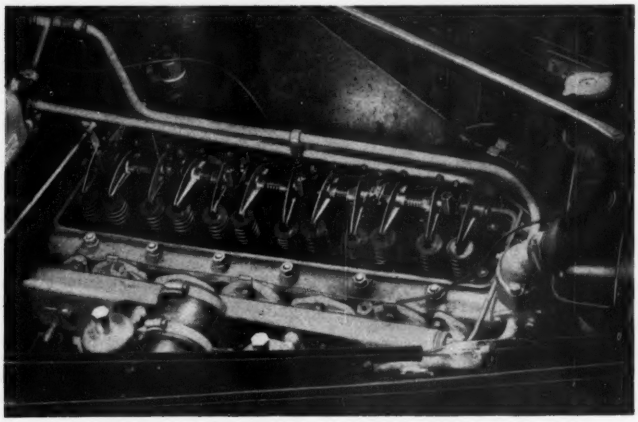


Slots and pressed-in thimbles direct coolant around the sparking plug bosses and valve seats respectively

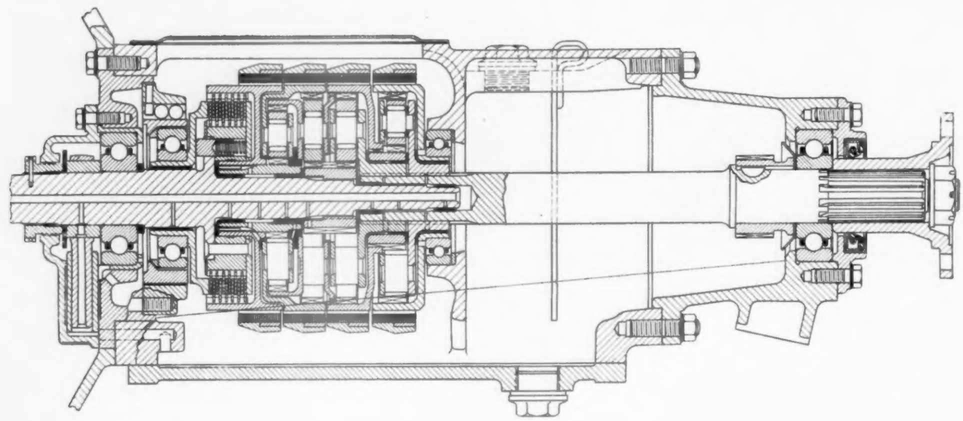
Seventeen En 54, cadmium-plated studs and nuts are used, in conjunction with a copper and asbestos gasket, to make the cylinder head joint. When the head is pulled down the distortion, which invariably occurs in any design, is no more than 0·0001 in. The pressed steel rocker cover is held down by four bolts screwed into long nuts on studs in the front, centre pair, and rear rocker pedestals. Pressed-steel stiffeners are spot-welded to the cover at these four points, but are visible in the illustration only at the front two. An oil-tight joint is made at the cylinder head with a laminated cork washer. This, together with rubber, sandwiched between dished washers under the four holding-down nuts and the rocker cover, is intended to form a resilient and, at the same time, damped mounting to locate the rocker cover and reduce noise. There is a press-on type oil filler cap in an adaptor on top of the cover at the centre.

A water pump of the normal impeller type is bolted to the front of the cylinder block. It is driven by a No. 5 construction, fabric-reinforced rubber, 35 deg V-belt made by the British Tyre and Rubber Co. Ltd. The cast iron pump-rotor, pressed on to an En 56 B spindle, has tapped holes for an extractor in its rear end. At the front of the rotor boss, a spring-loaded seal, made by the Morgan Crucible Co. Ltd., is housed in the cast iron pump-casing, and carries a moulded-in carbon-ring that bears against the rotor.

A forward extension of the pump body carries the spindle in two sealed ball-bearings. They are spaced by a $\frac{7}{8}$ in distance piece and lubricated through a grease nipple. The outer race of the front bearing is located between a flange in the casing at the rear, and a circlip, also in the casing, at the front. The inner races are clamped between the fan-belt pulley at the front end, and a flange on the shaft just forward of the water seal at the rear. Between this flange and the rear bearing is clamped a steel thrower ring. It works in a drainage space to prevent water leaking into the bearing The whole assembly is pulled up by a slotted and split-pinned nut at the front end of the spindle, the drive being furnished by a Woodruff key. On the front of the semi-steel 786 Grade 2, or Meehanite process B pulley, four



Arrangement of valve rockers. The cover bolts screw into special holding-down nuts on the pedestals



Pre-selective epicyclic gearbox

bolts secure a two-piece, four-bladed, pressed steel fan.

The manifolding is somewhat unusual. In the first place, separate porting is used throughout in view of the rather large valve overlap period. Secondly, in order to minimize movement, due to expansion at the junction with the cylinder head, the cast iron exhaust manifold is in two pieces. As a result, it has been necessary to incorporate a Y-junction lower down in the exhaust pipe. A third unusual feature is that instead of the more commonly used hot spot, the D.T.D. 424 inlet manifold is water-jacketed along its entire length. In fact, the whole of the by-pass circuit from the thermostat passes along the upper passage and back through the lower one. It is stated that in view of the large mass flow of water through this jacket, a considerable amount of heat can be taken from the water even when the engine is cold, to supply the latent heat of vaporization needed to assist carburation and distribution. Another claim made for this system is that when the engine is hot the water jacket screens the manifold from exhaust radiation.

Two S.U. horizontal carburettors, supplied with fuel from an AC hand-primed, mechanical fuel pump, are employed. A balance pipe connects both float chambers to the air intake, so that in the event of a choked air filter the additional depression will not increase fuel consumption. Uneven running due to aeration of the fuel under low pressure conditions at each jet orifice, is prevented by an interconnecting pipe between it and the float chamber. The cylinders of the carburettor are vented to the air intake to prevent, as far as possible, the entry of dust which might cause the pistons to stick. There is a short breather pipe between the rocker cover and the AC air cleaner and silencer. For export, an additional oil-bath air cleaner is fitted.

The D.T.D.424 cast aluminium sump, of 12½ pints capacity, is restricted at its forward end to clear the front suspension cross member. This has made it necessary to incorporate a blister at the rear to maintain the capacity. A drain plug is situated in the lowest position on the side so that, as far as possible, sludge will not be left behind when the oil is drawn off. Another plug is screwed into the bottom of the sump and locked by peening. It is flush fitting so that it will not cause damage if subjected to a glancing blow when moving over rough terrain. This plug is fitted below the pump inlet so that the engine may be bench-tested after assembly with an external oil circuit incorporating a centrifuge oil filter to remove swarf and impurities. Furthermore, in conjunction with the shroud on the pump inlet, it helps to ensure that any sludge or other foreign matter in the oil is not re-circulated through the lubricating system.

Oil is drawn from the sump by a gear-type pump, and passed to the gallery through a Tecalemit full-flow oil filter fitted with the usual by-pass safety device. A relief valve is incorporated in the oil gallery and maintains pressure at about 40 lb/in^2, and an electric oil pressure gauge is fitted on top of the filter casting. From the gallery, drilled in the crankcase wall, oil passes through drillings in the crankcase webs to an annular groove around each of the four main journals. Two holes are provided in each half-bearing shell to pass oil to the working surfaces as well as to drillings in the crankshaft serving the connecting rod big ends. Ducts from each main bearing supply the four camshaft bearings. From the front duct, a passage carries oil forward to a thimble-fitting with three drilled jets. It extends over the crankshaft timing chain sprocket on to which a drip feed is supplied. Another passage from the front duct carries oil to the thrust faces at the front end of the camshaft. At the rear bearing, two radial drillings communicate with each other, at the axis of the camshaft, from two narrow chordwise flats on its periphery. The drillings are set at such an angle that as the shaft rotates, they intermittently establish communication between the oil feed and an external pipe to lubricate the rockers. A longitudinally disposed flat helps to spread the oil over the bearing surface to ensure adequate distribution in spite of the fact that oil is drawn off intermittently. The external pipe carries the oil to drillings in the cylinder head and rear rocker pedestal communicating with the hollow rocker shaft. From there it is transferred through holes in the shaft to annular grooves around each rocker bearing.

A Lucas 12-volt coil-ignition system is employed. The contact breaker and distributor unit has a centrifugal-and-vacuum operated automatic advance and retard mechanism with a built-in micrometer adjustment. Timing is effected with the aid of marks on the flywheel which are visible through an aperture in the top of the bell housing. Lodge CB14 sparking plugs are fitted.

Fluid flywheel

The coupling consists of two main elements, the outer being the flywheel casing and driving member, is bolted to a flange on the crankshaft, while the other is the driven member splined to the gearbox mainshaft. Around the forged En 3 A casing is a pressed-on starter ring-gear. Grub-screws inserted with their longitudinal axes parallel to the axis of the ring at its peripheral junction with the outer member, furnish additional location. Spigoted and bolted to the rear of this outer member is the cast 195-60 aluminium alloy driving member, the joint being sealed with sodium silicate.

In a $1\frac{7}{8}$ in diameter bore at the centre of the driving member is a 2B8 bronze, flanged bush. This carries the hub, on the flanged front end of which is registered and bolted the D.T.D.428 driven member. Bearing on the outer periphery at the rear end of this hub is a Gaco seal housed in the driving member. A comparatively new feature on Daimler car chassis is the Sinclair disc-baffle positioned between the driven and driving member. At low r.p.m. the circulating oil impinges on this baffle which, apart from interrupting the circulation, deflects it out of the vortex chambers through ducts, not shown in the illustration, into the main flywheel casing. When the speed is increased, centrifugal force takes charge, and causes oil to flow again into the vortex chambers. At the same time it causes the vortices to move outwards and clear of the baffle, which then ceases to have any appreciable effect on the performance of the coupling. In this way, the 13 in diameter coupling, which is large enough to transmit maximum torque, can be employed; whilst transmission drag, associated with large diameter couplings at idling speeds, is almost completely eliminated.

In each of the vortex chambers there are two guide vanes. By this arrangement adequate directional control over the flow-vortices is maintained. At the same time the mass flow is less restricted than would be the case if these vanes were extended towards the axis of rotation of the members, to form a larger number of separate chambers. For convenience, two filler plugs are fitted on the rear of the driving member, either one of which may be used when topping up through a hole in the top of the bell housing.

Gearbox

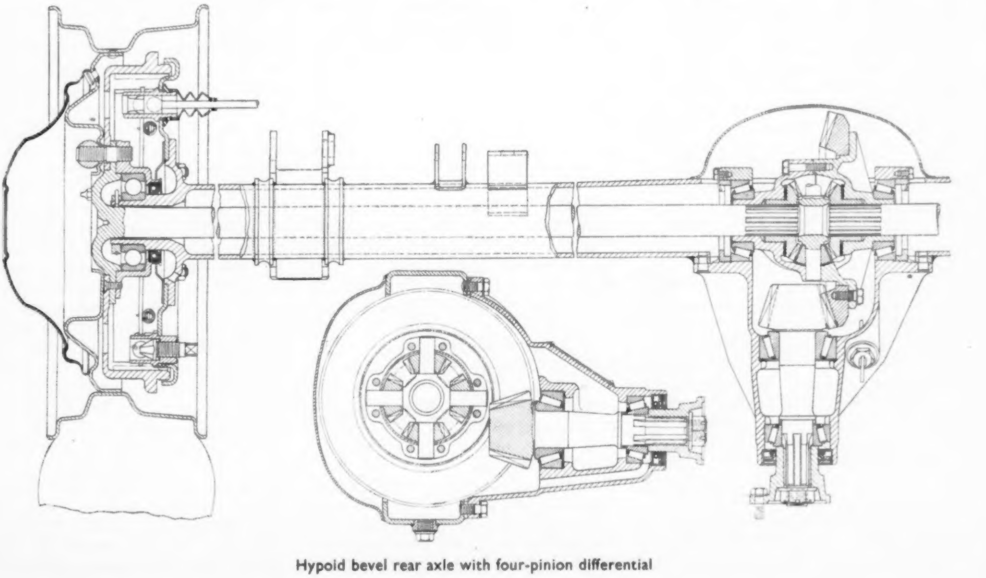
Only a summary of the principles of operation of the gearbox is given here, as it is to be the subject for a full description in a later issue. The principal part of the Daimler change-speed unit is the running gear. This consists of four simple epicyclic trains, interconnected to provide various combinations for the different speeds. The appropriate combination is brought into operation by brake bands which furnish the reaction, at the annulus in the case of reverse, first and second speeds, and at the sun wheel for the third speed. Top gear, on the other hand, is engaged by a clutch which locks the whole system together to provide a direct drive. The gear ratios are: top 1 : 1, third 1·56 : 1, second 2·32 : 1, first 4·108 : 1, reverse 5·4 : 1.

Each brake band is anchored in such a manner that the torque reactions are equal and opposite. Furthermore, the closing loads used to apply the brakes are also balanced. Thus, the gear trains and the mainshaft are relieved of any asymmetric loading.

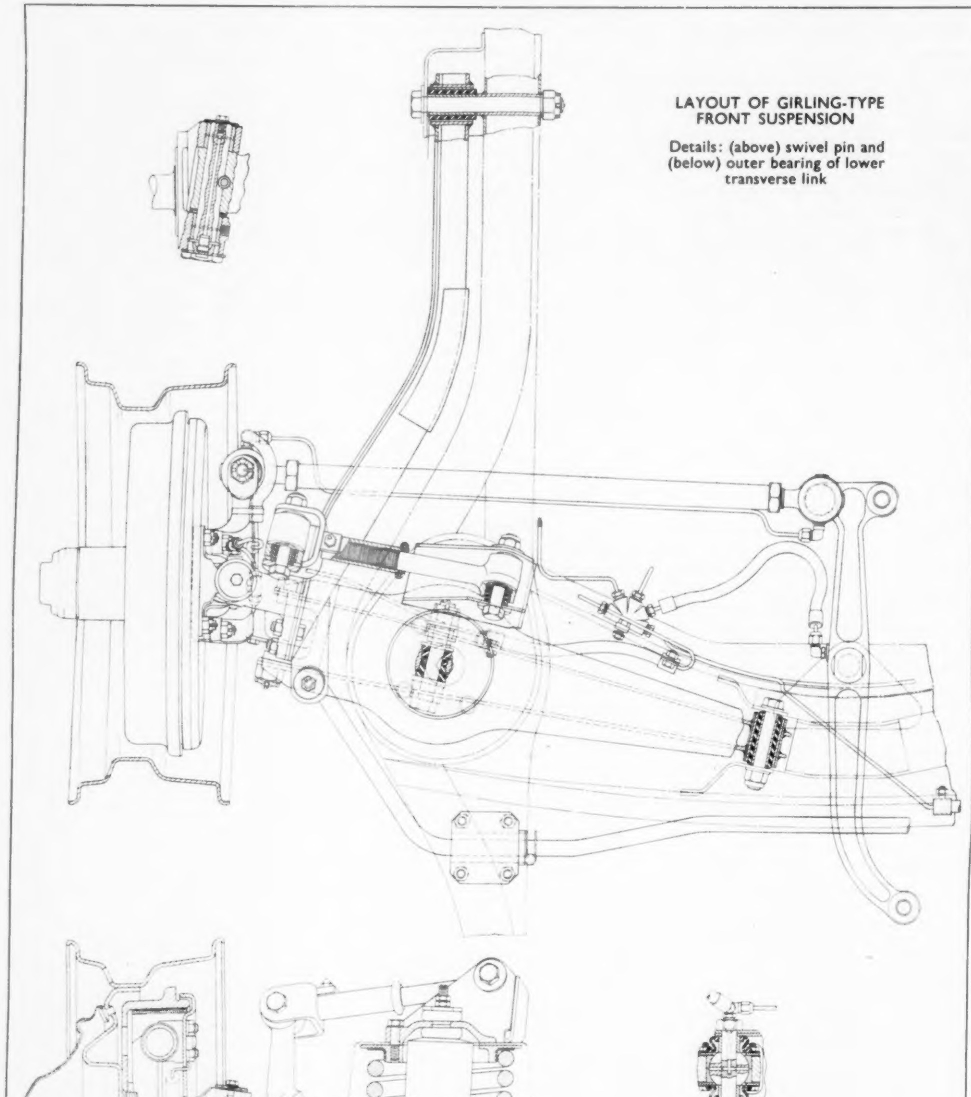
A bus-bar, extending the whole length of the epicyclic gear and clutch assembly, operates through a series of struts and toggles to apply the closing load to contract the brake bands on their drums and also to engage the clutch for the top speed. Wear of the brake linings is automatically compensated for, as it occurs, by a screw mechanism that shortens the length of the closing tie-rod. The strut, appropriate to the speed selected, is brought into contact with the bus-bar by a striker lever actuated by a camshaft. To control the camshaft position there is a selector lever on the steering column. Its motion is transmitted, through a system of bell-crank levers and rods, to a cross shaft situated in the box and geared to the camshaft.

Back axle

The drive is taken to the back axle by a 2 in diameter Hardy Spicer propeller shaft with needle roller bearings at the universal joints. A



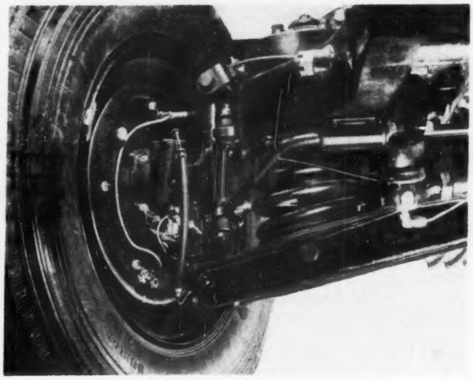
Hypoid bevel rear axle with four-pinion differential



LAYOUT OF GIRLING-TYPE FRONT SUSPENSION

Details: (above) swivel pin and (below) outer bearing of lower transverse link

Hardy Spicer intermediate bearing is flexibly mounted on the cruciform frame bracing member. Immediately to the rear of this bearing is the sliding joint. The axle is of the three-quarter-floating type. It has an En 3 A, or Rubery Owen 10-15 per cent carbon steel, banjo casing formed integrally with the 3 in outside diameter axle tubes. To the outer ends of these tubes, which have a wall thickness of $\frac{3}{16}$ in, are butt-welded the wheel hub supports. A flange on these members carries the brake back plate. A malleable iron nose piece is dowel-located and bolted to the casing, and the pressed steel rear cover is welded on. There is a filler plug and dipstick in the nose piece, and a drain plug in the bottom of the casing. A four-pinion differential is employed in conjunction with a hypoid bevel drive to give a ratio of 4·3 : 1. All the differential gears, pinions, and bearings are mounted on the nose piece.



A rubber-mounted, vertical connecting link allows for differential movement between the anti-roll bar and front suspension

Two taper roller bearings carry an overhung drive-pinion forged in En 39 B integrally with its spindle. A passage in the nose piece carries the lubricating oil, splashed off the crown wheel, to a space between the bearings through which it must pass to drain back to the lower part of the casing. End positioning of the pinion is effected at the front bearing, the inner race of which is clamped between a distance washer bearing against a small flange on the shaft and the internally-splined boss of the universal joint flange. The pre-load of the two bearings is governed by shims in front of the outer race of the rear bearing, the whole assembly being pulled up by a slotted and split-pinned nut and thick washer on the front end of the spindle. The lip-type Super oil seal bears on the outer periphery of the boss of the universal joint flange.

The En 36 crown wheel, $8\frac{3}{4}$ in diameter, has a tooth width of $1\frac{1}{2}$ in. Eight tab-washered $\frac{3}{8}$ in setbolts secure it to the differential cage. This is split vertically on the plane through the axes of the differential pinions. The halves are spigoted together and secured by eight tab-washered $\frac{5}{16}$ in setbolts, spaced one on each side of each arm of the 3S65 0·3 per cent carbon steel spider. There are phosphor bronze thrust washers between the outer spherical faces of the En 33 differential pinions and the cage. The bosses of the two En 33 differential gears are carried in the cage, the thrust being taken by a flat phosphor bronze washer around each boss.

Taper roller thrust bearings in a rearward extension of the nose piece carry, in their inner races, the differential cage. On assembly, the first adjustment is the bearing pre-load. It is effected by means of malleable cast iron ring nuts screwing up against the outer races in the nose piece. Then, lateral adjustment for position is made by loosening on one side and tightening an equal amount on the other side. Finally, a tab, secured to the nose piece by a setscrew, is used to lock the ring nuts, and the whole assembly is bolted to the banjo casing.

The inner end of each En 17 U half shaft is splined into its differential gear. On the outer end, an upset flange drives the road wheel and carries the BS 786 Grade 2 brake drum together with an En 8 Q housing for the single-row ball bearing. This is lubricated through a grease nipple on the flange. The inner race is held against a shoulder on the wheel support member by a nut locked by a circlip. At the inner end of the bearing-housing a Perfect oil seal is fitted. On the housing around the seal there is a lip forming a thrower ring to ensure that the oil, if any does leak past the seal, will be flung into a space between an oil retaining plate and the brake plate support flange in which a drain hole is provided.

Rear suspension

A 2 in wide semi-elliptic leaf spring with a rate of 135 lb/in is employed. All the leaves are of plain rectangular section. Four of them are $\frac{7}{32}$ in thick, and the other five are $\frac{3}{16}$ in thick. With the spring flat, its effective length is 46 in. The deflection under static load is 7 in, and the maximum deflection is $10\frac{1}{2}$ in. Compensation for weight transference, when braking, is effectively catered for by the front suspension, so the axle is positioned at the centre of the spring which is mounted horizontally.

Trunnion mountings overhung from the side of the frame carry the forged spring shackles, the spring centre line being offset $2\frac{1}{4}$ in from the outer face of the chassis side member. The trunnion pins are fitted at their outer ends with phosphor bronze bushes for the shackles, lubricated by the central automatic system. On the inner end of each pin, a slotted and split-pinned nut pulls it into a taper-ended tube welded in the side frame, so that it may easily be replaced when worn or damaged. The spring eye at the front end is carried on a bushed bolt in the body-mounting outrigger.

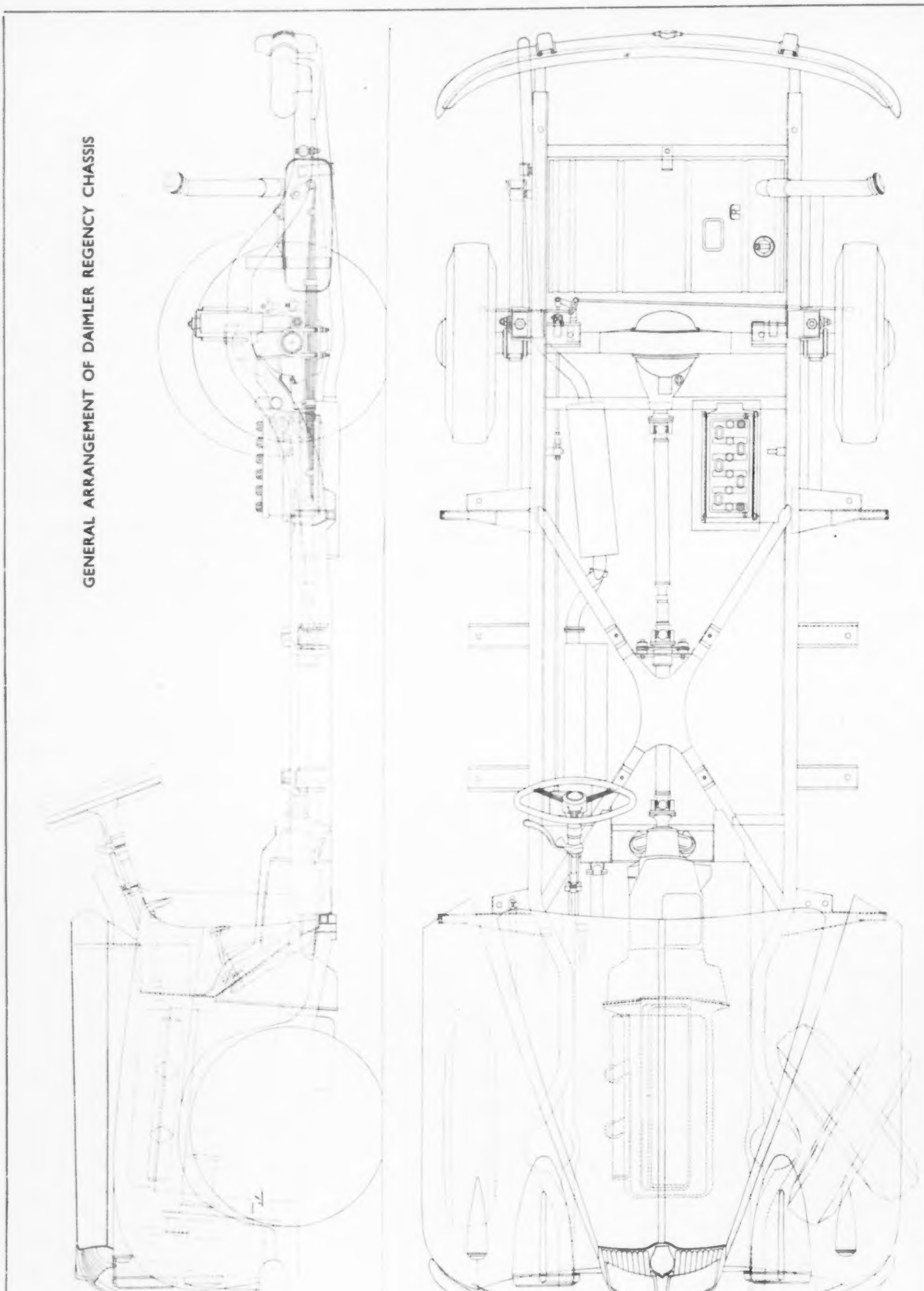
The Newton telescopic shock absorbers are of particularly sturdy design to incorporate the bump and rebound stops. Additional support at the full bump position is afforded by rubber stops under the frame side members. The shock absorbers are mounted vertically, the rubber-bushed ring-fitting on the lower end being on a bolt in an extension of the spring pad on the axle. At the upper end, a standard rubber sandwich fitting is carried by a bracket welded to the outer face of the frame side members.

Front suspension

The layout of the front suspension is somewhat unusual, although it is by no means new. The wheel stub axle is carried on a swivel pin that is mounted in a pedestal bolted to the front end of a radius arm which, at its rear end, pivots on a pin in an overhung bracket on the side of the frame. Thus, the reaction at the pivot, due to brake torque, tends to lift the front of the car. The length of the radius arm is so arranged that this tendency counteracts the nose-down effect of weight transference when braking.

A $\frac{7}{8}$ in outside diameter tube, welded in position through the frame side member, carries the En 16 R $\frac{3}{4}$ in diameter pivot bolt with its slotted and split-pinned nut. The outer end of the bolt is supported in a 10 S.W.G. bracket welded to the side of the frame. Clamped between this bracket and the tube in the frame, is the centre tube of a Metalastik rubber bearing, the outer tube of which is pressed in a tube welded in the end of the radius arm.

This radius arm is formed of a 10 S.W.G. top-hat section with a 10 S.W.G. closing plate on its outer face to box it in. In plan it is bent to

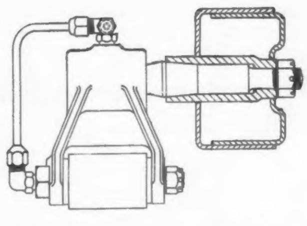


GENERAL ARRANGEMENT OF DAIMLER REGENCY CHASSIS

clear the wheel at full lock. To reinforce it at the bend a 10 S.W.G. patch plate of U-section is welded on the top-hat section member.

In place of the usual wishbone links there is, at the top, a single forged En 8 Q transverse rod $8\frac{3}{16}$ in long with, at its outer extremity, a screwed-on En 2 D fork-end. At the bottom there is a single 10 S.W.G. pressed steel transverse link $20\frac{13}{16}$ in long, of En 2 B, carrying the lower end of the spring and of the shock absorber. These two links take the side loads, and the differential loads due to the offset of the wheel centre line from the outer bearings. Pressed into the inner ends of both links are Metalastik rubber bearings carried in 10 S.W.G. lugs on the frame by $\frac{1}{2}$ in diameter En 16 R bolts with Simmonds locknuts. There is only a very slight rotary movement between the screwed-on fork end and the rod of the upper link, but it has been found necessary to lubricate it through a grease nipple. It carries a synthetic rubber seal at its inner end to keep out dust.

A 6 in outside diameter helical spring gives the system a periodicity of 62·1 c/min. It seats on rubber, of 80 Shore hardness, around a flanged hole in the flat upper face of the lower transverse link. It is located at its upper end around a boss on a ring in a 13 S.W.G. cup-shaped steel pressing welded to the top of the frame which, as can be seen from the illustration, is divided at this point. Secured to the ring by four bolts passing through the cup-pressing is a $\frac{1}{4}$ in thick steel cap, drilled at its centre to

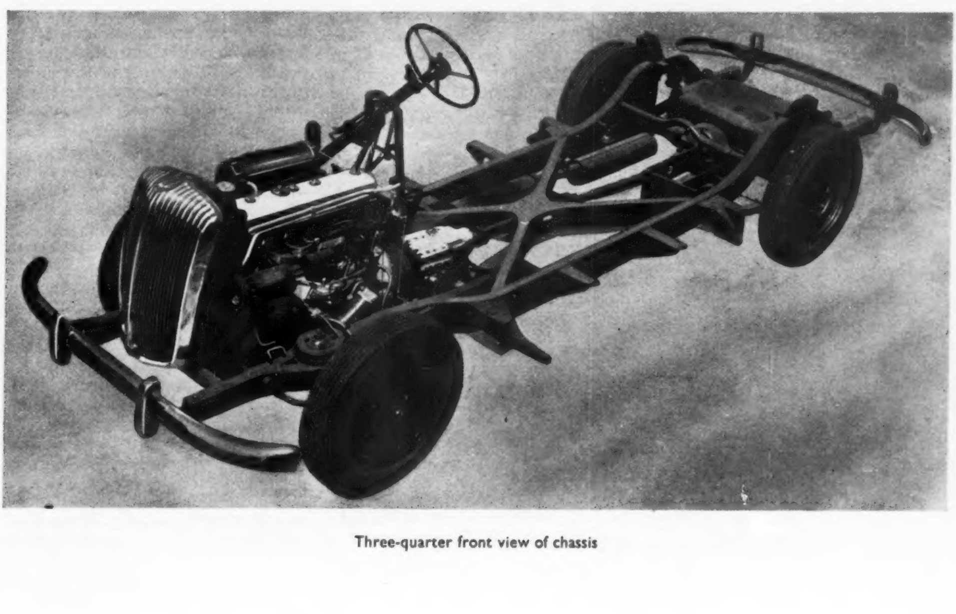


Replaceable spindle for forged spring shackle

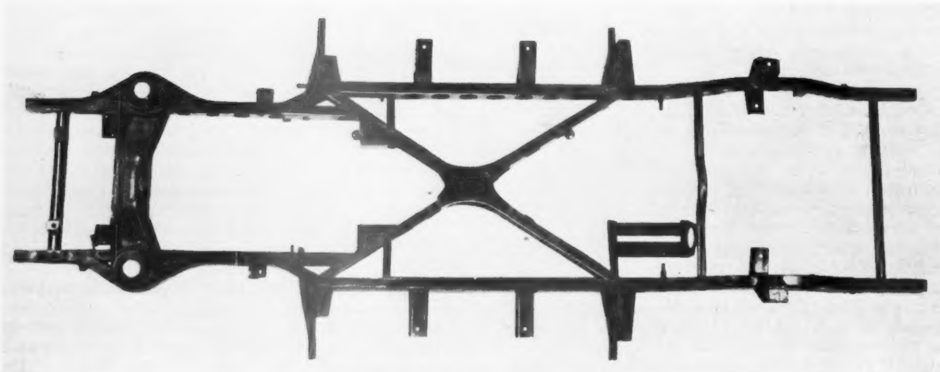
take the standard sandwich rubber end-fitting at the top of the Newton telescopic shock absorber. This is positioned with its axis coincident with that of the spring, and incorporates bump and rebound stops. The lower end of the shock absorber has the usual rubber-bushed ring-type end fitting carried between distance tubes on a $\frac{5}{8}$ in diameter bolt through the lower transverse link.

Four bolts secure the forged En 15 R swivel pedestal to the front end of the radius arm. At its upper and lower extremities are the outer bearings of the transverse links. The upper one is a Metalastik rubber bearing, similar to those used at the inner bearings, on a $\frac{1}{2}$ in diameter bolt. The lower one, on the other hand, is a spherical bearing giving a positive location to this point which, as can be seen from the illustration, is closely related to the steering geometry. Passing through the outer end of the lower transverse link is a $\frac{5}{8}$ in diameter En 16 U bolt. This carries the En 32 B ball between two distance tubes. The phosphor bronze spherical seating is divided vertically into halves. These are held in place by an end plate secured by four bolts on each side of the cylindrical housing in the pedestal. Synthetic rubber seals keep our foreign matter. The bearing is lubricated by the central automatic system, lubricant passing along the drilled axis of the bolt and thence through radial drillings at its centre to an annular groove around its periphery. From here it passes through radial drillings to the spherical bearing surfaces.

The En 33 swivel pin is carried in the pedestal, and is located by a cotter pin. It is at an angle of 9 deg from the vertical in a transverse plane and has a castor angle of 1 deg 30 min. The wheel camber angle is also 1 deg 30 min and the toe-in $\frac{1}{8}$ in. Hardened steel bushes at the top and bottom ends of the swivel pin carry the knuckle joints formed integrally with the En 15 R stub axle. Vertical bearing loads are taken by an En 32 A thrust disc carried in a cap nut screwed into the lower face of the knuckle. This disc bears against a $\frac{3}{8}$ in diameter insert, of the same material, in the lower end of the swivel pin. An arrangement such as this is an advantage in a fairly heavy car, as it gives rise to a comparatively frictionless swivel action. Lubrication is again effected by the automatic system through longitudinal and radial drillings in the pin. A Langite cork washer under a pressed steel retainer furnishes a seal at the top, and the joint between the lower knuckle and the pedestal is sealed by a similar



Three-quarter front view of chassis

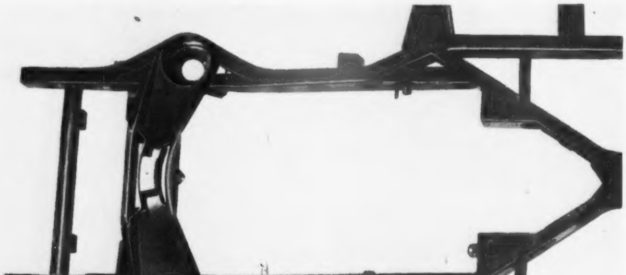


Effective bracing supports the cranked frame side members

retainer and felt washer.

A ¼ in thick lug, welded on the front end of each radius arm, carries an En 8 Q drop spindle for the ⅝ in diameter anti-roll bar made of En 45, B.H.N. 364-444. Hemispherical rubber bushes, between pressed steel retainers on the spindle, bear each side of the lug in a part-spherical seating welded into a hole in its end. The lower retainer abuts a shoulder on the spindle, and the upper one is pulled down by a Simmonds nut on the top end of the spindle. A similar arrangement of hemispherical rubber bushes and retainers is used on the lower end on each side of the flattened end of the anti-roll bar. This rubber-bushed drop spindle assembly is necessary to cater for differential movement between the anti-roll bar and the suspension. The bar itself is cranked forward and then passes transversely across the vehicle, being supported in rubber bearings bolted to the underside of the frame side members.

Two taper roller bearings carry the wheel hub on the stub axle, on the outer end of which is an adjusting nut used to apply the correct running clearance. It pulls up against the inner race of the outer bearing, the outer race of which bears against a flange in the hub. Thence the load passes through a shoulder in the inner end of the hub to the outer race of the inner bearing, which is positioned over the centre of the area of wheel contact with the ground. The inner race bears against a distance ring which positions it $\frac{9}{16}$ in from the shoulder at the steering knuckle. The distance ring has a radius on its inner face to clear a large fillet at the junction of the stub axle with the knuckle. Carried on the shouldered outer periphery of this ring is a felt seal, bearing against the inner periphery of the hub. Around this is an oil thrower lip that works in conjunction with an oil retaining plate in the same manner as at the rear wheel. Keyed to the outer, threaded end of the stub axle is a locking plate carrying a loose peg which engages in a drilled hole in the adjusting nut to lock it. Thus, the hub nut can be tightened and locked by a tab washer without disturbing the clearance setting. The wheels and the brakes are standard components.



Underside of frame front end, showing suspension attachment points

Steering

A Marles cam-and-roller steering gear is fitted, having a ratio of 13·75 : 1. The 18 in diameter wheel, splined on the top end of the column is adjustable. At the lower end, the steering box is bracketed to the side frame, just forward of the engine mounting. The drop arm is connected, by a rod fitted with adjustable fork ends, to the front end of a steering lever. The fulcrum point of this lever is approximately 9⅝ in to the rear, on a bracket on the frame front cross member at the centre. Approximately 6⅝ in from the fulcrum, a ball joint on each side of the rear end of the lever carries the adjustable steering rods. These are attached at their other ends, by means of the usual rubber-shrouded ball-joints, to trailing steering levers forged integrally with the steering pedestal. This arrangement, eliminating the track rod, is made possible by the unusually long lower front suspension links. The axes of the inner bearings of these pass through the centres of the ball joints on the lever when in the neutral steering position. All steering joints are lubricated by the central automatic system.

Frame

At the front end of the frame, one substantial cross member, curved in plan to clear the engine, carries the front suspension. In front of this a 2½ in diameter cross tube supports the radiator. At the rear, two 1¾ in diameter tubes, one in front and one behind the rear axle, brace the side members. These are of box section 4½ in wide × 12 in deep, built up of two channel sections in such a manner that the top and bottom faces of the box, carrying the tensile and compressive bending loads, are of double

thickness. On the Regency the frame side members are carried over the rear axle to give more ground clearance than in the Consort.

The usual channel section X-frame braces the centre of the structure and eight outrigger brackets support the body. A two-bolt attachment is used at each of the front pair of brackets. Two more pairs of attachment points are provided. One is on brackets welded to the inner face of each side member over the axle, adjacent to the shock absorber, and another is formed by a direct bolt attachment to the top of the frame side members at the extreme rear. The centre of the floor is supported on four mounting brackets on the X-frame. Balata packing is used on top of the brackets, and rubber is placed underneath, the whole arrangement reducing noise and vibration. All members, except the 10 S.W.G. front cross member, are of 12 S.W.G. The cross tubes are made of A2A-4 and all other members are of En 2 B.

The construction at the front end of the frame side members is worthy of note. On each side, the outer channel section sweeps around the suspension spring, returning to the inner section behind it. Still further to the rear, where the pedals are carried, the outer channel is cranked out and then continued straight through to the rear. The inner channel extends straight back from the point where the outer one parts company with it, until it joins the front part of the X-frame. This arrangement provides a continuous structure to carry the spring and shock absorber loads while, at the same time, it gives the necessary support at each point, where the frame side members are cranked. Between the X-frame and the side members, about 12 in to the rear of their front junction, is a channel section cross member. Aft of this, another channel-section member extends to the rear to complete the box section of the side frame. Forward of this, a closing plate is welded to the outer channel section.

A top-hat section forms the front cross member. Welded into it, to complete the box section, is a channel with its flanges turned downwards which, in conjunction with the sides of the top-hat section, furnishes support for the lugs that are welded in the channel to carry the lower transverse links of the suspension. The two front engine-mounting brackets are welded at the junction between the front face of the cross member with each frame side member. Two rear engine mounting brackets are provided on the X-frame, adjacent to the point where it is joined by the rearward extensions of the side frame inner channels.

Other features

The Daimler automatic chassis lubrication system is used for all points that would normally require a grease gun, except for one on the front end of each of the upper transverse links of the front suspension, one on each rear wheel hub, and one on the water pump. The system is operated by a small expansion chamber mounted adjacent to the Y-junction of the exhaust pipe. Non-return valves are positioned in the chamber so that, as the engine warms up, the oil is expanded and forced through the distributing pipes. Then, as the engine cools and the oil remaining in the chamber contracts, it is automatically replenished from a reservoir mounted in an accessible position high up on the dash.

Girling hydro-mechanical brakes of the two-leading shoe type are employed. They have 12 in diameter drums and a total friction lining area of 202 in^2. The foot pedal, of course, controls all four brakes, the front ones being hydraulically operated and the rear ones mechanically operated. A pistol-grip hand control is provided for the rear brakes. These are actuated by a straight rod extending from front to rear under the body floor on the right-hand side. At the rear, the usual drop link, mounted about 7¼ in aft of the spring eye on the inner face of the side frame, carries the rod. A Girling swinging link compensator is carried on the axle tube.

Lucas 12-volt equipment is used for the electrical system, which includes the usual compensated voltage control. The battery, of 64 amp-hr capacity, is situated under the rear seat cushion where it is readily accessible. Head lamps and fog lamps are built into the front of the wings, and separate parking lamps are blended into each crown line. At the rear, central number-plate illumination is used, together with a reversing lamp. In each rear wing there are combined tail lamps and stop lamps of the cheese-dish type. Inside the car, the usual dash illumination and indicator lamps, including those for trafficators, are fitted, as well as a roof light. Dual windscreen wipers are electrically driven.

INSTITUTION OF MECHANICAL ENGINEERS

Forthcoming Meetings of the Automobile Division

The following meetings will be held during February:—

BIRMINGHAM CENTRE

Tuesday, 26th February, 6.45 p.m. Annual General Meeting followed by Ordinary General Meeting in the James Watt Memorial Institute, York House, Great Charles Street. Address by the Chairman of the Automobile Division, C. B. Dicksee, M.I.Mech.E., entitled: "Experiences During Twenty Years of Oil Engine Development."

NORTH-EASTERN CENTRE

Wednesday, 20th February, 7.30 p.m. Annual General Meeting followed by Ordinary General Meeting in the University Chemistry Lecture Theatre, Leeds. Address by the Chairman of the Automobile Division, C. B. Dicksee, M.I.Mech.E., entitled: "Experiences During Twenty Years of Oil Engine Development."

NORTH-WESTERN CENTRE

Wednesday 27th February, 7.15 p.m. Annual General Meeting followed by Film Display in the Engineers' Club, Albert Square, Manchester.

SCOTTISH CENTRE

Monday, 18th February, 7.30 p.m. Annual General Meeting followed by Ordinary General Meeting in the Institute of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow. Paper: "The Diesel and Its Fuel," by S. Wightman, M.I.Mech.E.

WESTERN CENTRE

Thursday 28th February, 6.45 p.m. Annual General Meeting in the Royal Hotel, Bristol.

The following meetings will be held during March:—

LONDON

Tuesday, 11th March, 5.30 p.m. General Meeting at Storey's Gate, St. James's Park, S.W.1. Paper: "Shock Absorbers," by J. W. Kinchin and C. R. Stock.

COVENTRY CENTRE

Tuesday, 4th March, 7.15 p.m. Annual General Meeting followed by Ordinary General Meeting in the Craven Arms Hotel, High Street. Paper: "The Design and Development of Very Large Road Haulage Vehicles," by C. E. Burton, M.I.Mech.E.

DERBY CENTRE

Monday, 17th March, 7.0 p.m. Annual Meeting followed by General Meeting in the Midland Hotel, Derby. Centre Chairman's Address by Mr. A. A. Rubbra, B.Sc., M.I.Mech.E.

WESTERN CENTRE

Thursday, 13th March, 6.45 p.m. General Meeting in the Royal Hotel, Bristol. Paper: "Shock Absorbers," by J. W. Kinchin and C. R. Stock.

ELECTROLYTIC POLISHING

A Process for Treating Stainless Steels and Irons

As an alternative to the use of mechanical means for polishing stainless steels and stainless irons, The Galibier Engineering Co. Ltd., Bourne Mill, Farnham, Surrey, employ the Electropol process. This is an electrolytic process in which chemical action smooths the metal surface by wearing away the "high spots". The action is obtained by placing the components to be polished in a solution through which an electric current is passed. The chemical constituents of the solution are broken up into ions by the passage of the current. Some of these ions impinge upon and attack the surface to be treated in such a manner that the "high spots" are preferentially dissolved. The treatment continues until the required degree of surface smoothness and brightness is obtained.

In effect, the Electropol process may be regarded as the opposite of electro-deposition. That is to say, instead of the work forming a cathode on which metal from the anode is deposited, in the Electropol process the work is the anode and when the current is passed, metal is removed from the outer surface of the work.

Electrolytic polishing of stainless steels and stainless irons is not a new process, but it is only comparatively recently that it has been developed to a stage that makes its use commercially practicable. Originally there were several drawbacks. High current densities were necessary, the electrolytes were dear and the solutions unstable while the necessary plant was complicated and expensive and of low working capacity. Because of these factors the cost of polishing was high, and in addition, the results were not consistent because of the unstable solutions. With the Electropol process, relatively low current densities are employed and the solution, which is completely stable, is prepared from cheap and readily available chemicals. Consequently, the cost of polishing is low and the results uniformly good. In point of fact, the polishing cost is much lower than is incurred for mechanical polishing, even for articles of shape particularly suited to the process.

Comparison of electrolytic and mechanical polishing

Because of their toughness, stainless steels are difficult to polish by mechanical methods. For example, there is a tendency to generate localized high temperatures that can have a deleterious effect on the metal. Furthermore, if mechanical polishing is employed, there is a danger of distortion that may cause trouble since buckled sheet and strip are difficult to work. Mechanical polishing also tends to distort and de-nature the metal surface, thus decreasing its chemical resistance. In addition, particles of abrasive may become embedded in the surface and later give rise to "pit" corrosion; and since the polishing operation tends to flatten the "high spots" and drag them over the "valleys", sub-surface cavities may be formed.

Polishing by the Electropol process completely eliminates any danger of localized high temperatures and of work distortion, even on articles made of thin gauge material. It can also be carried out at the end of the manufacturing cycle so that there is no danger of damage to the surface during operations subsequent to the polishing. It can be applied to components which because of their form could not be polished mechanically. In contra-distinction to a mechanically polished surface, one that is electrolytically polished is completely homogeneous with the body of the metal and the surface is biologically and chemically clean. During the process the metal receives a certain amount of anodic passivation that increases the resistance to corrosion.

The amount of metal to be removed to produce a polished surface by the Electropol process is usually in the order of from 0·0005 to 0·0015 in. This is much less than the amount generally removed when mechanical polishing is employed.

Applications

The field for application is very wide and finished components from many different industries have been treated on a commercial scale. In the automobile industry, trafficator arms, radiator and bonnet mouldings and windscreen wiper parts are some of the components that have been treated in very large quantities, Apart from its use for polishing finished components, the process has several other interesting uses.

Surface stresses in metal can be relieved by the electrolytic action of this process. As a result, there are applications in which the Electropol process can be used instead of normal heat treatment to anneal work-hardened material. Where it can be used, annealing costs can be very greatly reduced since the necessity for a bright annealing furnace is obviated. It has shown remarkable results in inter-stage annealing between press operations. For example, in the production of a certain pressed component from a circular blank, the rejection rate was over 75 per cent. owing to radial splitting that occurred at the second press operation. Treatment by the Electropol process between operations reduced the rejections to less than 5 per cent. This suggests that the treatment might be very advantageous before a deep drawing operation.

Electrolytic action can also be used for de-burring and radiusing the profile of holes. It is particularly useful in this respect when the burr is thrown up inside the component and is therefore difficult to remove by mechanical means. The Electropol process has also been used for correcting shafts that have been produced slightly oversize. Normally, such a shaft would be mounted in a lathe or plain grinder and then carefully machined to the correct size. In many cases the excess metal can be removed much more cheaply by the Electropol process. The metal is removed uniformly to leave a perfectly circular shaft with a satisfactory bearing surface.

Chromium Plated Piston Rings

The reduced wear of rings and cylinders obtained by the use of chromium plated top rings is attributed by E. W. Portmann, writing in *A.T.Z.*, September 1951, to (1) The increased resistance to abrasive wear resulting from the greater hardness of chromium, 700-1,000 B.H.N. against 230-280 B.H.N. for cast iron. (2) The considerably smaller sensitivity of chromium to corrosion caused by combustion products. (3) Less frictional heat, since the coefficient of friction of chromium is smaller than that of cast iron. In further explanation of the reduced bore wear it is pointed out that the hard layer takes up no abraded particles as do unchromed fire rings.

Any abraded particles, moreover, are reduced by the plated ring to a very fine size and rendered less harmful.

In spark-ignition engines, a chromium layer 0·07-0·09 mm thick reduces ring wear to half or one-third and cylinder wear to as little as a quarter. With diesel engines, sleeve wear on the average is about halved, and ring wear may be appreciably reduced.

Wear rate of the rings has proved better with hard sleeves especially when these have a martensitic structure. In diesel engines, the rate of wear of the chromium layer, 0·015-0·020 mm per 10,000 km, is higher. The thickness of the plate on the ring is hence increased to 0·10-0·15 mm, which gives a sleeve life of 200,000 km and ring life of 80,000-100,000 km according to driving conditions. (*M.I.R.A. Abstract No.* 5604)

TRACTOR MANUFACTURE

A Survey of the Production Methods for the New Fordson Major

A TRACTOR that is completely new in all respects has recently been developed by the Ford Motor Co. Ltd., Dagenham. It is designated the Fordson Major, and is now in production. The power unit may be either a petrol, diesel, or vaporizing oil engine. For economy both in manufacture and servicing, the three types of engines have been designed to have as many common parts as possible. For example, the cylinder block, the crankshaft and the connecting rods are common for all three types. The cylinder head, on the other hand, must be designed specifically for one type of engine.

A complete re-tooling has been carried out for the production of the new tractors. In addition, the whole tractor division has been reorganized so that as far as machining, assembly and testing functions are concerned, it is now a self-contained unit. Although in planning the machining operations, it has not been considered advisable to employ complex multi-station transfer machines, such as are used in the production of Consul and Zephyr cylinder blocks, there are many interesting features in the tractor machining lines.

Cylinder block machining

A common cylinder block is employed for all three engines. It is designed to incorporate easily removable wet cylinder liners. The machining line is laid out so that the blocks pass from left to right from start to finish of the operation sequence. Transfer from one machine to the next is effected along a roller conveyor at 34 in from floor level. Except for two drum mills, all the machines in the line have a loading height that allows the work to be pushed straight into position.

The first machining operation is carried out on a special Sundstrand milling machine on which four location spots are milled on the head face. Loading into this machine is effected with the head face uppermost and the front end leading. These location spots are important inasmuch as they govern the machining of the sump face at the next operation. To ensure they are correctly positioned, the fixture on the Sundstrand machine is designed to give location at eight points on the rough casting, two on the water jacket side, four on the inner edge of the crankcase and two on top of the crankcase flange at the water jacket side. A cutting speed of 250 ft per minute is employed.

During transfer from the Sundstrand machine to the second machining operation, the block is passed through a Ford turn-over unit, in which it is turned through 180 deg to bring the sump face uppermost. An Ingersoll six-spindle drum mill is used for the second machining operation. This machine is illustrated in Fig. 1. The casting is first loaded into a fixture on the left-hand side of the machine with location taken from the four location spots on the head face. In this position the sump face is rough, semi-finish, and finish milled. For the roughing cut two cutters are used, one 10 in diameter, having 26 blades and the other 12 in diameter having 30 blades. For the finishing cut a 20 in diameter cutter with 42 blades is employed. The respective cutting speeds are: roughing, 176 ft per minute, semi-finishing, 176 ft per minute, and finishing, 228 ft per minute.

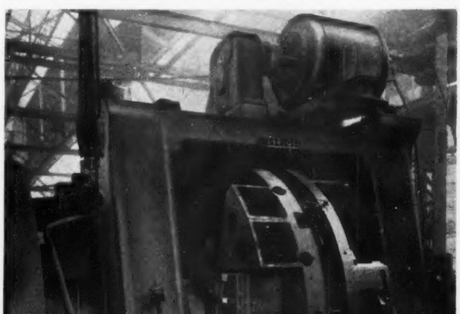


Fig. 1. Six-spindle Ingersoll drum mill for machining the sump and head faces of the Fordson Major cylinder block

When the drum has completed its revolution, the casting is unloaded and re-loaded into the fixture at the right-hand side of the fixture. Location is taken from the sump face, and at this setting, roughing and finishing cuts are taken across the head face. The first two spindles carry 9 in diameter cutters each with 20 blades for roughing cuts, while the third spindle used for finishing carries a 12 in diameter cutter having 24 blades. The finishing cut actually leaves 0·015/0·020 in of stock to be removed at a much later operation in the machining sequence. The cutting speeds are: roughing, 85 ft per minute, semi-finishing, 85 ft per minute, and finishing 225 ft per minute. This Ingersoll drum mill carries five fixtures at each side. Each of these fixtures has its own independent hydraulic clamping system.

As it leaves the Ingersoll drum mill, the block has two accurate surfaces, the head face and the sump face, for height location. Accurate longitudinal and transverse location points are provided by the next operation, which is carried out on a special four-spindle inverted drilling machine of Ford design. The casting is loaded into the fixture with the head face uppermost and the front end to the right. The casting rests on the sump face, while longitudinal location is taken from extreme points in the water jacket, and transverse location from two spots on the water jacket side. At this setting, two holes are drilled and reamed in the sump face. These holes are used as location points for practically all the subsequent operations.

When the casting has been located in the fixture, hydraulic clamps are applied and the work cycle is initiated by push button. Two drill heads advance from below the work, two holes are drilled and the heads retract. The work fixture, which is carried on two large circular rails, is then automatically shuttled to the right to bring the drilled holes below two other drill heads in which reamers are mounted. The reaming heads advance, the holes are reamed, the heads retract, the fixture shuttles back to the starting position and the clamps are released, and the casting is ready for the next operation.

A four-spindle Ingersoll drum mill is used for the next operation. It has six work fixtures on the drum. The casting is loaded with the front end to the right, and with location taken from the sump face and the two reamed holes in the sump face. At this setting the front end of the block is milled from the right-hand side of the machine and the rear end from the left-hand side. A roughing and finishing cutter are mounted at each end. At the front end, roughing is effected by a 9 in diameter × 22 teeth cutter and finished by a 9½ in diameter cutter with 20 teeth. The cutting speeds are: roughing, 105 ft per minute, and finishing, 150 ft per minute. For machining the rear end, the roughing cutter is 12 in diameter and has 30 teeth and the finishing cutter is 12 in diameter and has 24 teeth. The cutting speeds are the same. On this Ingersoll drum mill the casting is clamped manually, whereas on all other machines throughout the line hydraulic clamping is employed.

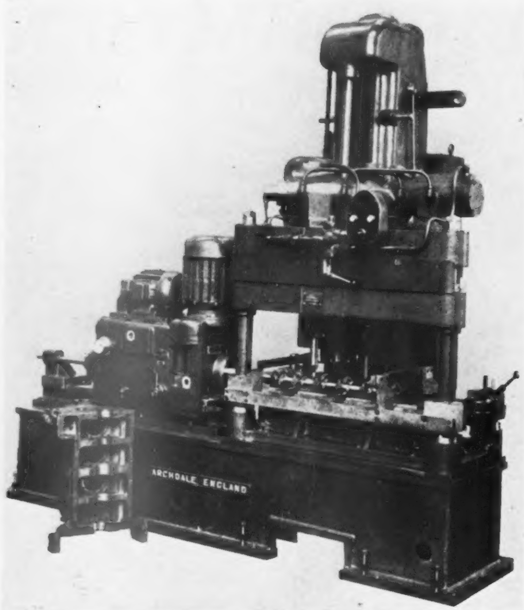


Fig. 2. Archdale two-way horizontal and vertical borer for roughing half-bearing bores and core drilling the distributor and oil pump bores

A Baush four-spindle, heavy-duty cylinder borer is used for the next operation. On this machine the top and bottom bores for the cylinder liners are rough bored and the top bore is also counterbored. There is very heavy stock removal at this operation which leaves 0·050/0·060 in of stock to be removed from the bores and 0·015/0·020 in to be removed from the depth of the counterbore at later operations.

From the cylinder borer, the casting is transferred to the first of the many Archdale machines in this line. It may be observed that these Archdale machines have been specially built up from standard units for use on these tractor cylinder blocks. Many interesting features are incorporated in the work fixtures. The first Archdale machine is a two-way machine with two horizontal heads. The casting is loaded in to the machine with the head face uppermost and the rear end to the right, and location is taken from the sump face and the two reamed holes. In the left hand head of this machine there are two spindles, one carrying a core drill for rough drilling three cam bores from the front end and the other carrying a core drill for drilling right through the auxiliary drive bore. For machining from the rear end of the casting, the right-hand head carries three spindles. One carries a core drill for rough drilling two cam bores, one a tool for rough boring the starter bore, and the third a tool for machining a radius in the flywheel housing flange. As all these tools have heavy duty to perform, live snout spindles are fitted. All the bores dealt with at this operation are machined to leave $\frac{1}{16}$ in to be removed from the diameters at later operations.

Fig. 3. The tooling for rough boring the main bearing half-bores on the Archdale machine illustrated in Fig. 2. The block is pushed into the fixture at conveyor height, and the fixture and block are then automatically lowered into the working position

Another Archdale machine, a special two-way horizontal and vertical borer, shown in Figs. 2 and 3, is used for the next operation. On this machine the main bearing half bores are rough machined from the horizontal head to leave 0·06 in to be removed from the diameter at later operations, and from the vertical head the distributor and oil pump bores are core drilled. The casting is loaded into the work fixture with the head face uppermost and the rear end to the right. It is loaded at a height that clears the cutters for machining the main bearing half bores. When the block is correctly located in the fixture and the clamps have been applied, the fixture is automatically lowered to bring the work into the machining position. The horizontal head then advances, the bearings are machined, the head retracts and the fixture is raised to the unloading position.

Milling operations are then carried out on two Kearney and Trecker travelling-head milling machines. Each of these machines incorporates a transfer bar. The first of these machines, of which the control panel and the loading end are shown in Fig. 4, has two heads, one on each side of the transfer bar. Each head has one spindle. The starter pad is milled from one side and the water pump pad from the other. A 15¾ in diameter × 32 teeth cutter at a cutting speed of 275 ft per minute is used on the starter pad, and a 5 in diameter × 10 teeth cutter at a cutting speed of 260 ft per minute on the water pump pad. A block is pushed into position beneath the bridge piece, see Fig. 4, on which the control panel is mounted and a completely automatic cycle is initiated by means of a push button. The cycle is:—the work is carried into position by the transfer bar, locating dowels register in the reamed holes in the sump face, the clamps are applied hydraulically, the heads travel past the work and return to the starting position, and the clamps are released. On the initiation of the next cycle, the casting is

carried forward by the transfer bar towards the next machine. It comes to rest beneath another bridge piece that incorporates a ratchet device arranged to prevent any danger that the return stroke of the transfer bar might carry the casting back to the machining position.

The second Kearney and Trecker machine is tooled to mill the push rod cover face and adjacent location pads, the distributor pad, location pads on the edge of the sump face flange, and a rear engine mounting pad on the valve side of the block. There are a 3 in diameter cutter with 8 teeth, a 5 in diameter cutter with 10 teeth and a 6 in diameter cutter with 12 teeth. The respective cutting speeds are 310, 260 and 310 ft per minute.

A Sundstrand special rise-and-fall milling machine, see Fig. 5, is used at the next operation. Once again the casting is loaded into the machine with the head face uppermost and the rear end leading. A rise-and-fall machine is used at this operation because a flange on the casting prevents the use of an ordinary travelling-head machine. There are two milling heads, one on each side of the work fixture. The front head carries a $3\frac{1}{2}$ in diameter cutter with 8 teeth for milling a rear engine mounting pad on the water jacket side at 225 ft per minute cutting speed, while the rear head carries two 4 in diameter cutters for milling the oil filter and fuel pump pads. The cutters are retracted to clear the work on the return stroke.

Another Sundstrand rise-and-fall milling machine is employed at the next operation. The tooling on this machine is shown in Fig. 6. In all, 12 cutters are used, and at one setting the inner face of the front main bearing is milled, the other four main bearings are straddled milled to width, and an oil groove is milled in each main bore. Two arbors are used for mounting the cutters, and each arbor is independently driven, one from the right-hand end and the other from the left-hand end. The work is pushed on to the work carrier and when the cycle is started it is automatically lowered and fed in to the cutters and then automatically retracted.

An Archdale two-way horizontal boring machine, see Fig. 7, is used at the next stage. Once again the work is loaded into the machine with the head face uppermost and the rear end leading. There are three live snout type spindles in the left-hand head of the machine. They carry cutters for counterboring the cam bore, the auxiliary drive bore and the water pump bore. As with all other counterboring operations on the Archdale machines, the feed mechanism makes provision for a predetermined dwell at the end of the feed stroke. There is only one spindle in the right-hand head. It carries a boring bar on which four cutters are mounted, two for rough machining the exhaust mounting seats and two for rough machining the injector pump mounting seats. In each

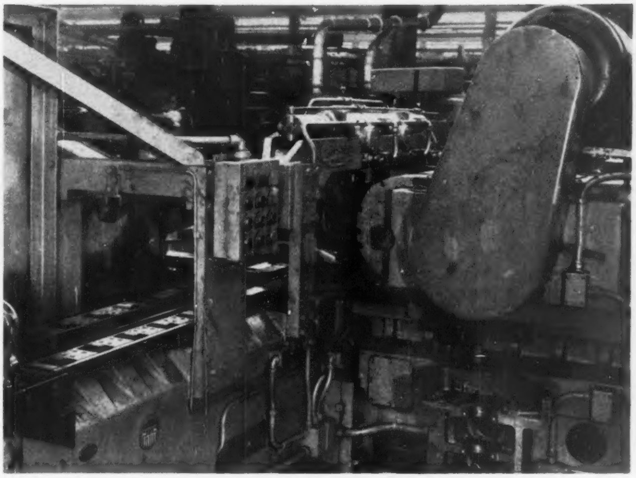


Fig. 4. Control panel and loading station for Kearney and Trecker travelling-head milling machine, with single-stage transfer bar

case 0·015 in of stock is left for removal at later operations. The right-hand head is arranged for draw-cut feed.

From the fourth machining operation, that is, from milling the front and rear ends on the Ingersoll four-spindle drum milling machine, up to this stage, the casting at every operation has been loaded with the head face uppermost and the rear end leading. For the next operation, the block must be turned round 180 deg to bring the front end to the leading position and through 90 deg on the longitudinal axis to bring the water jacket side uppermost. In this position it is loaded into a Kearney and Trecker special horizontal milling machine in which the main bearing locks are rough milled to leave an allowance on depth and width for removal at a subsequent broaching operation.

Before any further machining is carried out, the casting is loaded on to a special carrier, see Figs. 8 and 9, on which it remains for several operations. This use of a carrier plate has been adopted to simplify the drilling and similar operations that have to be carried out on the sump and head faces and the front and rear ends. It is, of course, desirable to deal with as many holes as possible at each setting. This entails the use of two or three, generally three, multi-spindle heads simultaneously.

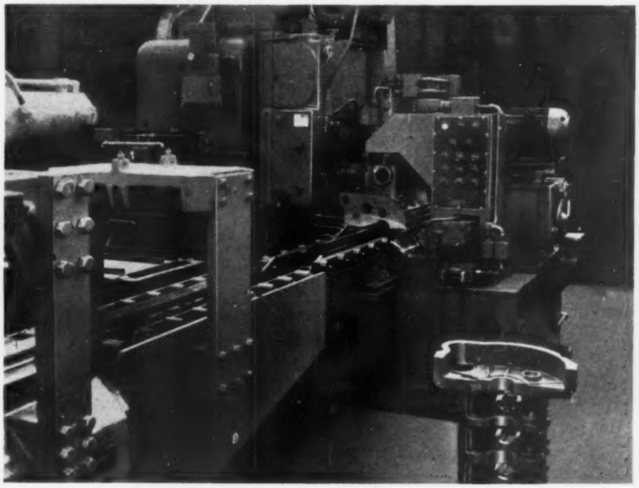


Fig. 5. Special Sundstrand rise-and-fall milling machine

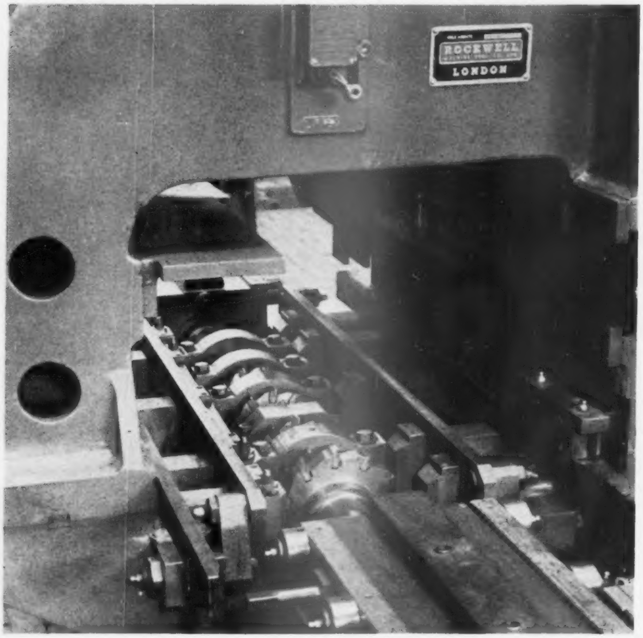


Fig. 6. Tooling for machining bearing widths and milling oil-hole grooves on a Sundstrand milling machine with a rise-and-fall head

From every point of view, horizontal head machines are to be preferred for this type of operation. However, the use of such machines appeared to have one drawback, the difficulty of loading the block into the work fixture with the head and sump faces in the vertical plane and the difficulty of transfer between the machines. This difficulty has been eliminated by the use of these special carriers.

It must be stressed that the carrier is not a jig plate that gives accurate location. It merely allows the work to be handled easily between machines and to be loaded easily into an approximately correct position in the work fixture. The casting is loaded on to the carrier in the position shown in Fig. 9. For loading into the work fixture there is a short length of independent roller conveyor at each machine station. This is mounted on slide rails running at right angles to the roller track so that the carrier and work can easily be pushed into the loading position. A fixed guide rail on one side of the work fixture and a spring-loaded guide rail on the other contact the sump and head faces to guide the block as it is pushed into the machine.

A positive stop at the back of the fixture gives approximate transverse location. When the casting has been brought into the approximate position, the dowel pins for registering in the reamed holes in the sump face are advanced. The carrier plate holds the casting at such a height that the tapered end of each pin enters the appropriate hole, and as the pins advance they lift the casting some 0·015 in to bring it to the correct location. An interesting method has been employed to allow the casting to be lifted easily on the dowel pins. The block weighs some 180 lb but it is carried on spring-loaded plungers in the carrier. The springs are so loaded that the dowel pins have to raise only a weight of 10 lb. At the end of the work cycle, the dowel pins are retracted and spring-loaded, and positive injectors move the block sufficiently to allow it to fall gently back on to the carrier.

For the first three operations after the casting is loaded on to the carrier, combined Baush and Archdale machines are used. The company had a number of Baush driving units that were not required for other work, and multi-spindle drilling heads have been fitted to them by James Archdale and Co. Ltd. At the first of these machines the work is loaded with the sump face leading, so that the rear end and the sump and head faces are brought into position. From the head at the rear of the machine, 12 tapping holes are drilled, while from the right-hand head 25 holes are drilled in the sump face and 10 tapping holes for the main bearing studs are also drilled. From the

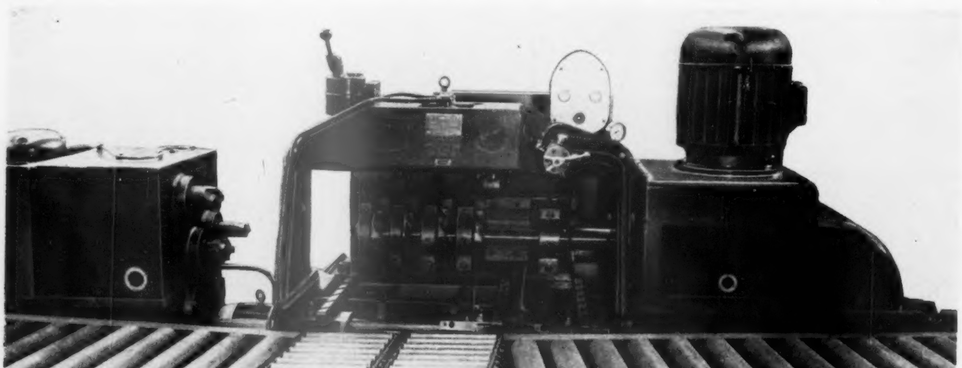


Fig. 7. Archdale two-way horizontal borer for roughing the exhauster and injector mounting seats, and counterboring cam bores

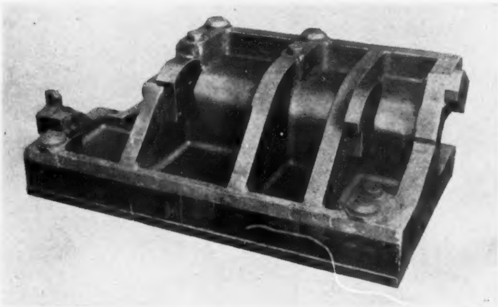


Fig. 8. Carrier plate for Fordson Major cylinder block

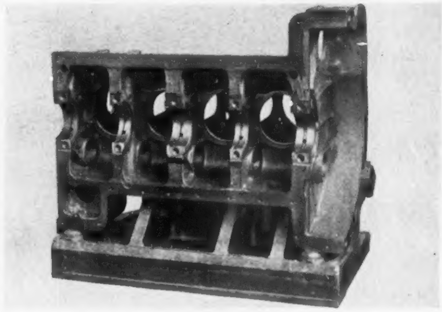


Fig. 9. Carrier plate with block in position

left-hand head 14 tapping holes are drilled in the head face, the tachometer drive bore is core drilled and a small hole is drilled in the bottom of this bore.

The same loading position is employed at the next machine. On this machine nine holes in the rear end are countersunk, three are reamed and the drilling of an oil gallery is continued to a depth of 11 in. At the same time 24 tapping holes in the sump face and the 10 holes for the main bearing studs are countersunk, and one hole is drilled adjacent to the distributor drive bore from the right-hand head, while eight tapping holes are drilled in the head face from the left-hand head.

Before the next operation the carrier, and with it the block, is turned through 180 deg so that the front end of the casting comes into position for drilling from the rear of the machine. In all, 25 tools are mounted in the rear head for operation on the front end of the block. There are two combination tools for drilling and countersinking, 22 drills for tapping holes and one for drilling the oil gallery hole part way. At the same time 21 holes in the head face are countersunk ready for tapping and two holes are drilled and countersunk from the right-hand head. Five milling heads are mounted on the left-hand head, see Fig. 10. One cutter is mounted on each attachment for milling a location slot in each main bearing half bore. These milling heads are independently adjustable up and down to compensate for cutter wear.

From this stage on, all drilling and similar operations are performed on machines of Archdale design and manufacture. For the next operation an Archdale 3-way horizontal machine is used. This machine is shown in Fig. 11. A 24-spindle reciprocating head is mounted at the rear. It countersinks 22 holes in the front end, drills one ½ in hole and continues the drilling of the oil gallery until it breaks through into the oil gallery hole drilled from the rear end of the block. A reciprocating head is also fitted at the left. This is a five-spindle angular head for drilling four oil holes from the main bearing half bores into the cam bores and one deep oil hole through No. 4 cam bore.

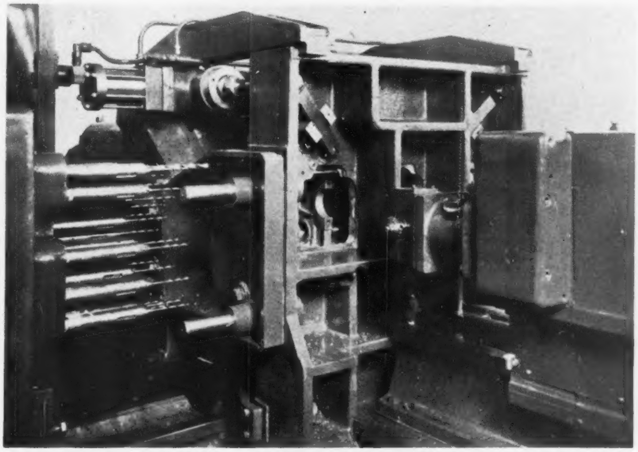


Fig. 10. Three-way machine with Baush driving units and Archdale heads. Five milling attachments are fitted to one head

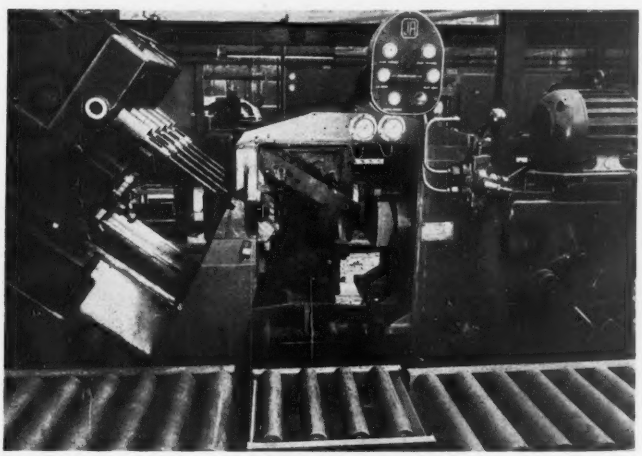


Fig. 11. Archdale three-way drilling machine with reciprocating angular head for drilling deep oil holes

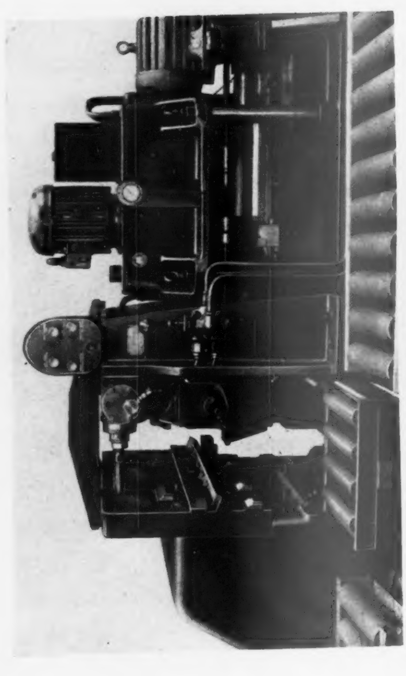


Fig. 12. Archdale three-way machine; the left-hand head is arranged to give almost inverted drilling

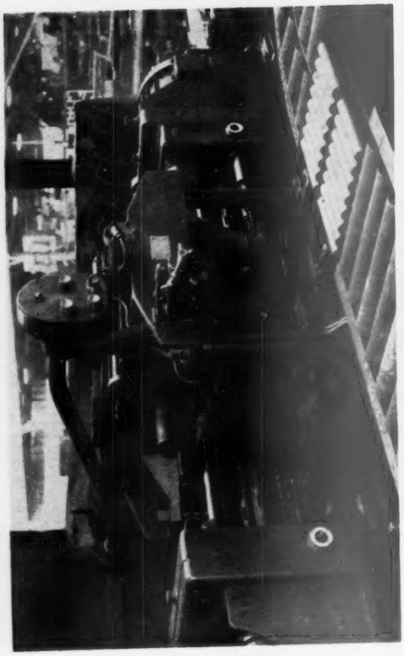


Fig. 13. Archdale three-way machine with one head for boring and two for multi-drilling operations

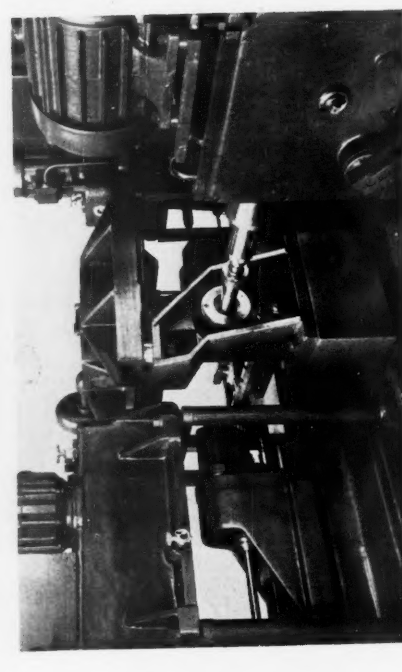


Fig. 14. The rear of an Archdale three-way machine showing the outfeed tool

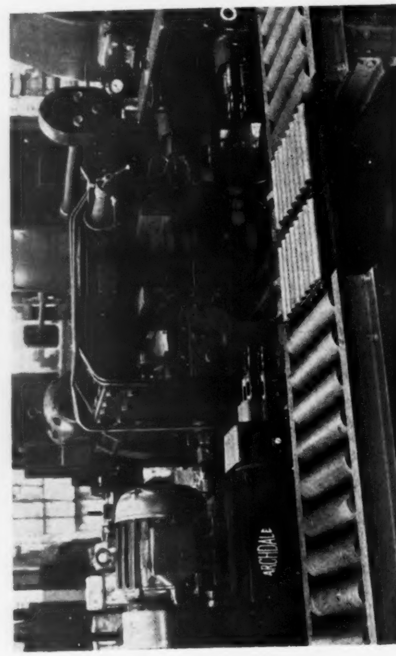


Fig. 15. The final drilling machine in the cylinder block machining line

Fig. 16. Ex-cell-O two-spindle borer with the cylinder block on the swivelling fixture

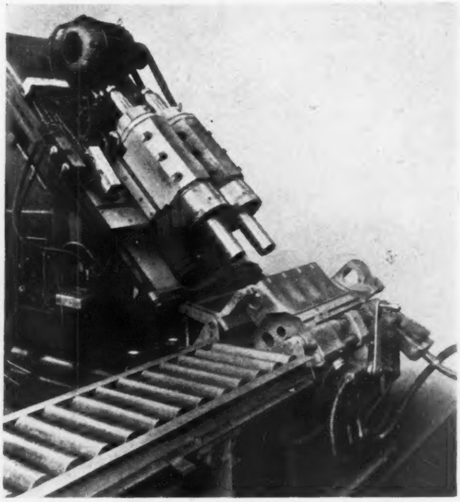


Fig. 17. The cylinder block in the boring position on the machine shown in Fig. 16

One fairly deep hole is drilled in the head face from the right-hand head which is a cam-feed unit.

Another special Archdale three-way horizontal, multi-spindle drilling machine, illustrated in Fig. 12, is used for the next operation. On this machine the rear head is a cam-feed unit, the right-hand head a reciprocating unit, and the left-hand head a cam-feed unit for drilling upwards at an angle approaching the vertical. A single deep oil hole is drilled part way in the front end of the block from the rear head, while another oil hole is drilled through from the head face to the cam bore from the right-hand head. The left-hand head is used for drilling four oil holes from the main bearing half bores to the oil gallery hole. The block is then transferred to an Archdale two-way, horizontal drilling machine. On this machine a reciprocating head is fitted at the rear. It is used for drilling an oil hole to depth from the front of the block. The other head, at the right, spot faces an oil hole in the head face and reams and spot faces the tachometer drive bore. This completes the operations for which the casting is mounted on the carrier.

At the next operation, carried out on the Archdale three-way machine illustrated in Fig. 13, the block is located on the sump face with the valve side leading. This brings the front end and the valve and water jacket sides into the machining position. The rear head is a cam feed unit that carries a boring bar with two tool bits for semi-finishing two diameters of the auxiliary drive bore. This operation leaves 0·015 in in the diameter for finish machining later. The right-hand head which operates on the valve side of the block is of the reciprocating type. From this head, two deep holes are drilled, one an oil feed hole and the other the governor rod hole; 14 holes are also drilled from the right-hand head. In the water jacket side of the casting, 9 holes are drilled from the left-hand head.

An excellent example of the manner in which James Archdale and Co. Ltd. construct machines for special purposes from standard units is given at the next operation. This is a three-way machine. It is illustrated in Fig. 14. Once again the loading is such that the front end of the block is machined from the rear head, and the valve and water jacket sides from the right- and left-hand heads respectively. Only light duty is required from the right-hand head which has to drill two holes and counterbore one in the valve side of the block. For this, a light reciprocating type head, without the reciprocating mechanism, is used. A full reciprocating type head is fitted at the left for counterboring one hole and drilling a deep oil feed hole. A standard single spindle head is fitted at the rear. It carries a special out-feed recessing tool for grooving and chamfering the auxiliary drive bore. The tool holder can be seen in Fig. 14. Out-feed becomes operative when a stop on the spindle contacts the face of the cylinder block.

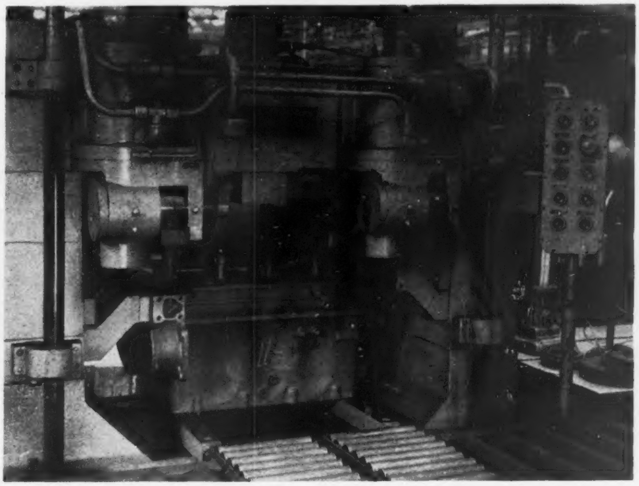


Fig. 18. The cylinder block in the initial position on an Ex-cell-O machine for line boring main bearing and cam bores

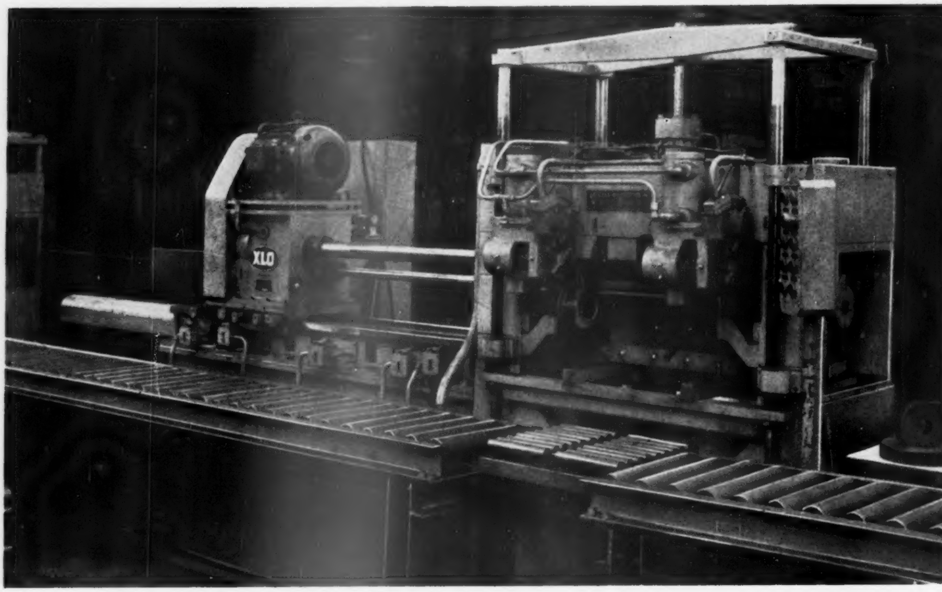


Fig. 19. The Ex-cell-O machine with the block in the working position

For the next operation, which is also carried out on an Archdale three-way horizontal multi-spindle drilling machine, location is again taken from the sump face and the two reamed holes but the block is turned to have the water jacket side leading. The single spindle rear head is a cam feed unit with a single spindle carrying a boring bar with two tool bits for finish machining the starter motor bore. From the right-hand head, one hole is reamed, one hole and two bosses are spot faced, four holes are drilled and four countersunk in the water jacket side, while from the left-hand head six holes are countersunk, five are counterbored, five are drilled and bosses are formed and spot-faced into the distributor wall. The fixture used for this operation incorporates hydraulically-operated moving bush plates for the operations on the water jacket and valve sides of the block. These bush plates are moved clear to allow the block to be loaded into the fixture. Then, when the clamps are attached and the work cycle initiated, they are automatically brought into position, and after the heads have retracted they are automatically moved clear to allow the fixture to be unloaded and reloaded.

To complete the drilling and associated operations on the head and sump faces, the ends and the sides of the block, the casting is transferred to yet another three-way Archdale machine, Fig. 15, with the valve side leading. In this machine three step drills in the rear head drill and countersink three holes in the starter pad. This head is a cam feed unit with a long extension. From the left-hand head four holes in the rear engine mounting pad are countersunk in the water jacket side, while from the right-hand head one hole is drilled in the oil filter pad, four rear engine mounting holes are countersunk and the counterbore of the governor rod hole is reamed in the valve side.

All the necessary tapping on the head and sump faces, the front and rear end faces, and the valve and water jacket sides is completed in three successive operations on W.F. and John Barnes multi-tapping machines. On the first of these machines, 24 holes are tapped from the rear head in the front end of the block. At the same time 19 holes are tapped in the valve side of the block and 12 in the water jacket side. At the second tapping machine, three holes are tapped in the starter pad and 10 in the head face. To complete the tapping operations, 10 holes are tapped in the rear end of the block, 34 in the sump face and 14 in the head face on the third Barnes multi-tapping machine.

At this stage the block is given a cold wash and is then transferred to an Ex-cell-O boring machine, see Figs. 16 and 17. This machine is used for semi-finishing the bores for the cylinder liners. It is tooled to semi-finish the counterbore for diameter and depth, to semi-finish and chamfer one edge of the top bore, to semi-finish the bottom bore and a groove for the sealing ring. An hydraulically-operated pivoting work fixture is used. For loading, the fixture is in the position shown in Fig. 16 so that the block can be pushed straight on from the roller track. The fixture is then pivoted to bring the casting into position beneath the heads.

There is a completely automatic work cycle. The heads advance and bore and counterbore on Nos. 1 and 3 cylinders, at the end of the advance stroke an hydraulically-operated outfeed tool is brought into action to

Fig. 20. Ford design machine for water test on cylinder blocks

machine the groove below the bottom bore. This tool is then retracted and the heads retract. The fixture is then shuttled automatically to bring Nos. 2 and 4 cylinders into line with the heads and the cycle is repeated. From this machine, the work is transferred to an exactly similar machine on which the same operation cycle is employed to finish machine the same elements.

The main bearing locks are then finish broached to size on a Weatherley hydraulic horizontal surface broaching machine. Three important operations follow. They are all carried out on special Archdale vertical multi-spindle drills. The first of these machines has nine spindles, eight for drilling the tappet holes, while the ninth carries a boring bar for semi-finishing three diameters in the oil pump and distributor bore. This spindle is of the live snout type. On the second machine, the eight tappet holes are semi-finish reamed and on the third they are finish reamed. Identical fixtures are used on all three machines, and on the first and second there is a rise and fall bush plate on the head that goes down into the casting as the head advances.

At this stage the casting is again given a cold wash. The main bearing caps are then fitted and the block is transferred to a special Ford facing machine. On this machine the thrust faces on the centre main bearing are machined to width and diameter. A Corona drill press with a cam feed and a special head carrying two small milling cutters then mills a slot in each side of the centre bearing cap.

Two Ex-cell-O machines are then used for the important operations of machining the main bearing bores and the cam bores. One of these is used for semi-finishing and the other for finishing these bores. These machines have several interesting features. Each boring bar carries all the necessary tool bits for working on five bores. It is therefore necessary to make special provision for advancing the bars through the rough drilled bores and the bar guides to the machining position, and for retracting the bar when the machining is finished. For this reason, spindle rotation is so controlled that the bars always come to rest with the tools in the lowest position, and the bar guides are grooved at the lowest point to allow the bars to be passed through. Special provision is also necessary in connection with the block itself. From the roller track, the casting is loaded into the position shown in Fig. 18. A fully-automatic cycle is then initiated. This is: the block is raised to a position that will allow the boring bars and tool bits to pass through the main bearing and cam bores; the driving head then advances until all the tools are in the correct position; cam operated clamps then contact beneath the flange of the sump face and lift the block into the clamping position; spindle rotation starts and the head advances at feed rate; at the end of the cut the spindles stop with the tool bits in the lowest position; the cam-operated clamps are released to allow the block to fall on to the lifting rails in a position that allows the bars to be retracted; and finally the lifting rails are lowered to the loading position. The machine, with the block in the boring position, is shown in Fig. 19.

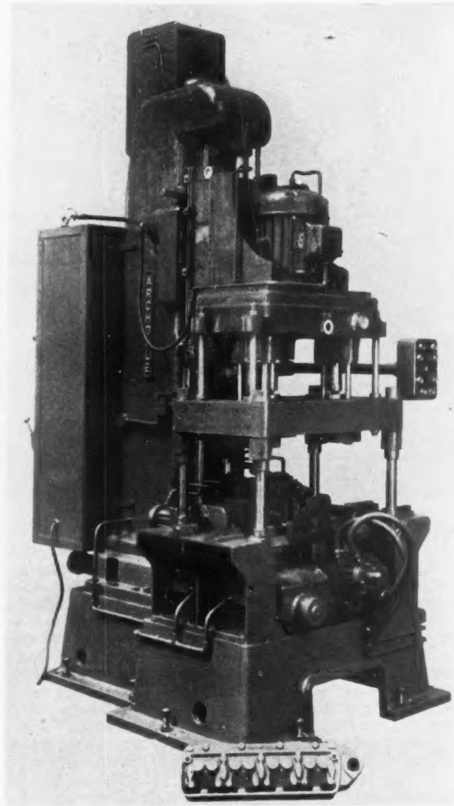


Fig. 21. Archdale machine with a special shuttling fixture for drilling, reaming and spot facing location points on the cylinder head

A special Ex-cell-O machine is used at the next operation. It incorporates a milling head at the rear, a vertical boring head and a horizontal boring head. On this machine the injector and exhauster seats are finish machined from the rear milling head, while from the right-hand head the auxiliary drive bore is finished for diameter and counterbore, and the vertical head finish machines the oil pump and distributor drive bores. To complete the machining operations on the cylinder block, a light milling cut is taken across the head face, the counterbores for the liners are finished for depth, and two

Fig. 22. Newton rotary table machine for milling cylinder head, joint and rocker cover faces

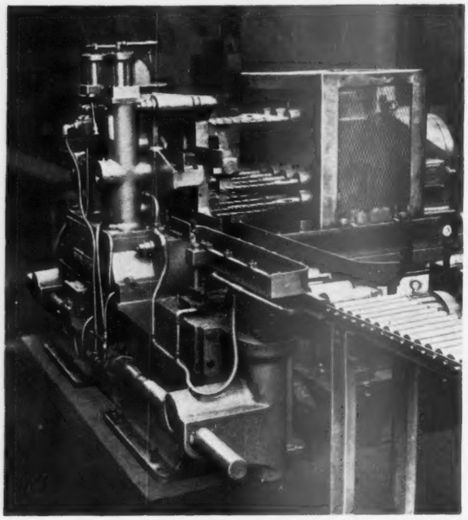


Fig. 23. Special Archdale two-stage machine for drilling operations in the cylinder head

holes are reamed in the rear end. The casting is then given a hot wash, the sealing rings and the cylinder liners are fitted, and the assembly is given a water test on the Ford machine illustrated in Fig. 20. After a cold wash, the cylinder block is given a complete inspection before transfer to the engine assembly.

Cylinder head machining

A common cylinder head for petrol, vaporizing oil and diesel engines is a manifest impossibility. It is therefore necessary to produce three types of head. Since the total number of heads required is the same as the number of cylinder blocks produced, the planning engineers were confronted with the problem of obtaining optimum machine utilization so that there would be the maximum economy in production. Certain operations on the diesel type head are additional to and completely different from the machining operations on the petrol and vaporizing oil type heads. For these operations there was no alternative to installing machines that would be used for them only, with the consequence that they must stand idle for periods. For other operations it has been possible to adapt the machines for use on any type. In the main, this end has been achieved through clever planning of the work fixtures which allow change-over from one type to another to be effected quickly with a minimum of lost time.

On all three types, the first operation is to machine location spots on the cover face. A Baush vertical drill is tooled up for this operation on the diesel heads and an Archdale for the petrol and vaporizing oil heads. One of these machines is shown in Fig. 21. Since the same principle is employed on both machines, it will suffice to describe the operation for the petrol type head. The casting is loaded into the fixture with the rocker cover face uppermost, and location is taken from Nos. 1 and 4 combustion chambers and from a spot on the joint face. When the casting is in position, the fixture drops and the clamps are applied. The fixture then moves back and the head advances to drill two holes in and spotface two bosses on the rocker cover face. When the head retracts, the fixture is automatically moved to a second position. The head then advances again and the two holes are reamed, and a third boss on the rocker cover face is spotfaced.

At the second operation, the joint face and the rocker cover face are rough and finish milled on a Newton rotary table milling machine, see Fig. 22. The fixtures on this machine are arranged alternately so that when the joint face has been milled on the first pass, the head is turned over and transferred to the next fixture for milling the rocker cover face. This machine is used for all three types of head, but

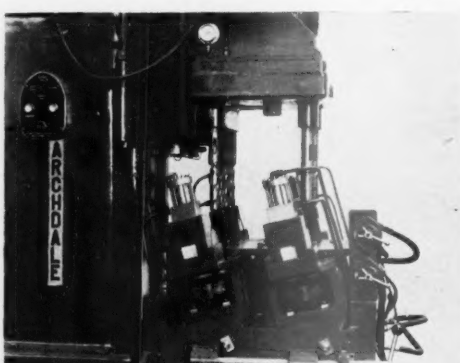


Fig. 24. Archdale vertical drilling machine with two-stage swivelling fixtures to accommodate all three types of Fordson Major cylinder heads

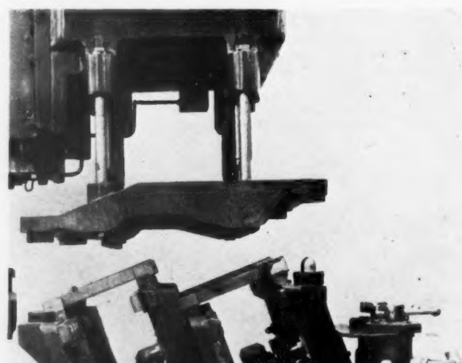


Fig. 25. Drilling head and angular fixture used in drilling and spot facing the spark-plug holes in cylinder heads for petrol and vaporizing oil engines

while the setting is the same for petrol and diesel heads, a slight adjustment for height is necessary for vaporizing oil heads. The third operation is carried out on a duplex Cincinnati mill with retracting heads. On this machine the manifold face is finish milled from one head and two lifting bosses are finish milled from the other. The same setting is used for all three heads.

For the next operation the casting is transferred to a special two-stage Archdale horizontal multi-spindle drill. Once again this is a common operation. The drill head is a typical Archdale unit and the interest lies in the special Archdale loading equipment that has been designed to work with the machine. For the first stage, at which 14 bolt holes are drilled through, the casting passes into the fixture from the right at working height. It is then withdrawn from left to right and lifted up to the second stage where the three remaining bolt holes are drilled. From the second stage, the casting passes out to the left and is then lowered to the roller conveyor height.

For raising the casting, there is a short length of independent roller conveyor at the entrance end, and for lowering, another length of independent roller conveyor at the exit end. Movement of these lengths of conveyor is effected by means of hydraulically-actuated rack and pinion movements. The actuating system is so balanced that movement cannot be effected until both castings are in position. This machine is illustrated in Fig. 23.

At the next operation, which is performed on an Archdale vertical multi-spindle drilling machine, the setting and tooling is common for all types. A two station fixture is mounted on the machine table. At the first station, two holes are drilled in the water outlet face and five in the rocker pads. At the second station, one hole is drilled, five holes in the rocker pads are chamfered and the thermostat hole is bored and counterbored. A snout type boring spindle is used for machining the thermostat hole.

Valve elements in the head are machined on the next five machines. In each case an Archdale vertical multi-spindle drilling machine is used with a two-station fixture mounted on the machine table. Since these elements on the petrol and vaporizing oil type heads must be machined at an angle of 13 deg to the normal and those on the diesel type heads are machined normal to the joint face, swivelling type fixtures as illustrated in Fig. 24 are used.

The operational sequence through the machines with swivelling type fixtures is:—

1st machine.
Position 1. Rough drill four inlet and four exhaust throats.
Position 2. Finish form face round inlet seats.

2nd machine.
Position 1. Drill eight valve guide holes.
Position 2. Chamfer eight valve guide holes.

3rd machine.
Position 1. Semi-finish ream eight valve guide holes.
Position 2. Spotface eight valve spring seats.

4th machine.
Finish ream eight valve guide holes.

5th machine.
Position 1. Rough counterbore exhaust valve insert seats.
Position 2. Finish counterbore exhaust valve insert seats on the petrol and vaporizing oil heads, and finish bore the exhaust throats on diesel type heads. The tools are piloted in the valve guide holes.

At this stage there is an operation on petrol and vaporizing oil heads which is not required on the diesel heads. On an Archdale multi-spindle vertical drilling machine with fixed two-stage angular fixtures, see Fig. 25, four spark plug holes are drilled from the first position and four spark plug seats are spot faced from the second. A rise-and-fall bush plate is attached to the head of this machine.

The four succeeding machines are used for all three heads, although there are minor differences in tooling. The first is an Archdale duplex multi-spindle drilling machine on which holes are drilled in the sides of the casting. On the second, an Archdale deep hole drilling machine with a reciprocating head, a deep oil hole is drilled. Tapping on two multi-head tapping machines completes the machining on the petrol and vaporizing oil head castings, which are then washed and inspected before transfer to the cylinder head and valve guide assembly station. Several further machining operations are necessary on the diesel head before assembly.

Assembly for petrol and vaporizing oil heads is started by pressing in the valve guides on a Mills press. The valve seat inserts, which are shrunk in liquid, are then assembled into the exhaust seat counterbores. An air pressure test for leaks is then carried out, the water jacket being tested at 30 lb per sq in and the oil passage at 80 lb per sq in. Three further operations complete the petrol, or vaporizing oil, head ready for washing and inspection before transfer to the engine assembly section. At the first of these operations, the valve guide bores are reamed and the rims of the inlet valve throats are skimmed on an Archdale vertical multi-head drilling machine. On a similar machine, the inlet and exhaust valve seats are cut to within 0·004-0·008 in of finished size. To ensure concentricity the tools pilot in the reamed valve guide bores. Finally, the inlet and exhaust seats are finished to size on a Hall valve seat grinding machine. Incidentally, the assembly and machining sequence is the same for the diesel type heads and is carried out on the same machines.

One of the features of both the cylinder block and the cylinder head lines is the rapid metal removal at all milling operations. This is a result of the company's practice of employing machines with adequate power and great rigidity to allow heavy cuts with high speeds and feeds. So far as other machining operations are concerned, the general conditions for speeds and feeds are: drilling, cutting speed 65-70 ft per minute, feed 4·5 in per minute; tapping, feed 10-15 in per minute; rough bore, cutting speed 160 ft per minute, feed 8·0 in per minute; finish bore, cutting speed 300 ft per minute, feed 3·0 in per minute.

(To be continued)

PROBLEMS IN THE USE OF SOLUBLE OILS

DURING metal-working processes such as grinding, emulsions of oils in water are used for cooling. Under these circumstances, ferrous metal is liable to a type of staining removable only by further machining, and another difficulty is the objectionable odour which often develops in the emulsion. Details of three techniques which were used to study the changes in emulsions made with waters of different hardness in contact with iron chips are given by A. W. Lindert in *Lubrication Engineering*, October 1951.

Of alkaline or reducing agents and corrosion inhibitors tested, none gave satisfactory control of stain development. Maintaining the emulsion concentration by adding fresh oil delays but does not prevent staining. Hard waters appear to promote staining.

Commercial emulsions were found to be heavily infected with bacteria. All the organisms isolated were aerobic. Some types multiply and promote rapid staining of ferrous metals without causing objectionable odour. No germicide was found capable of controlling these organisms in soluble oils.

Remedies suggested to combat stain development are: (1) Match the soluble oil used to the prevailing water hardness. A hard-water-type soluble oil should be avoided where a soft-water type gives satisfactory emulsions. (2) Ensure rapid and adequate removal of iron chips, especially the fine chips produced in grinding. (3) Avoid prolonged use of emulsions on finish-grinding operations. (4) Prevent contamination of emulsions by food and other organic debris favouring bacterial growth. (5) When stain tendencies have already developed in the emulsions system, rinse the finish-ground part in fresh emulsion, and change the wash solutions at least daily. (*M.I.R.A. Abstract No.* 5622.)

TWO-STROKE ENGINES

Consideration of the Petroil Lubrication System

THE prospect of the introduction of an economy car has lately been the subject of discussion in both the technical and the non-technical press. Furthermore, several manufacturers are known to be giving attention to this matter. The crankcase - compression - scavenged two-stroke engine is, in some respects, regarded as an ideal power unit for such a vehicle. It would seem, therefore, to be not inappropriate to consider some of the problems associated with the lubrication of the two-stroke engines of that type.

In an article entitled "Two-stroke Lubrication" in *The Motor Cycle*, Dec. 27th, 1951, Dr. Alan Wolf outlines, from the point of view of the oil technologist, some aspects of this problem that are of interest to both designers and users. The chief merits of the petroil system, of course, are its simplicity and reliability. However, as the power output per unit volume is increased the stage may be reached where the inadequacies of this system become a factor limiting the attainment of higher engine efficiency. This stage it would appear has been reached already in at least one engine. In the last 125 c.c. T.T. race the engine of one of the Continental competitors was lubricated on the petroil system augmented by an additional supply of neat oil injected into the carburettor air intake.

The effectiveness of the petroil system depends to some extent upon the care with which the owner or driver replenishes his fuel tank. Since ordinary motor oils made up of green oils are, like petrol, based almost entirely on liquid hydrocarbons, they readily dissolve when well mixed with petrol to form a clear homogeneous solution. Furthermore, they will then remain in that state indefinitely and show no sign of separation even in the coldest weather. However, the mixing of the relatively heavy and viscous oil with the petrol requires some care. Possibly this aspect should receive more attention than has been the case hitherto, and a simple mixing device incorporated with the filler tube might be developed.

Green oils are just as soluble in benzole, and petrol-benzole mixtures, as in petrol. They are not, on the other hand, soluble in methanol, ethyl-alcohol, or any blended fuel very rich in alcohols. In such cases, castor oil or castor-based lubricants should be used. On the other hand, these will not dissolve in petrol or petrol-benzole mixtures.

Viscosity

One of the most interesting features of the petroil system is that it violates a fundamental precept of more positive systems of lubrication, according to which every precaution is taken to keep the lubricating oil and the fuel apart. The addition of even small proportions of petrol to lubricating oils decreases their viscosity to a remarkable degree. For example, the addition of as little as 3-5 per cent of petrol to an S.A.E. 30-grade oil, having a viscosity of 200-255 units Saybolt at 130 deg F, will reduce its viscosity to that of an S.A.E. 20-grade oil having a viscosity of 140-150 units at 130 deg F. Again, from 8-10 per cent fuel dilution will reduce the viscosity of an S.A.E. 30-grade oil to as low as that of an S.A.E. 10 oil having a viscosity of 90-120 units at 130 deg F. The viscosity of a lubricating oil is usually regarded as its most important single property.

Careful tests, in both small liquid-cooled four-stroke petrol engines and small two-stroke diesel engines, have shown that when they are operated at relatively high cylinder cooling jacket temperatures and high crankcase temperatures, the wear of cylinders and piston rings decreases progressively with increasing viscosity. In some cases wear is almost inversely proportional to the true or absolute viscosity of the oil at some standard temperature such as 210 deg F. In other cases, below a critical viscosity of about 50-60 units Saybolt at 210 deg F, corresponding with motor oil grades of about S.A.E. 20 to S.A.E. 30, the wear rate in hot engines has been found to increase sharply at a rate much higher than the inverse proportional to the absolute viscosity at 210 deg F.

The petroil system

Petroil mixture issues from the carburettor jet in the form of a spray or mist of very small droplets. It seems probable, therefore, that in its passage from the jet through the crankcase to the combustion chamber, some of the petrol component of the spray evaporates. Thus, the wet gas passing through the crankcase will, in the later stages of its journey, consist of droplets of oil-petrol mixture richer in oil than the original petroil mixture in the tank. This enrichment of the droplets, however, will not be sufficient to increase their viscosity to the point where they can provide satisfactory lubrication.

A much higher degree of separation of the oil and petrol components takes place, no doubt, in the droplets that strike the hot interior surfaces of the crankcase, the cylinder walls, piston interior, crankshaft, and connecting rod. Each individual petroil droplet, coming into contact with such a surface, spreads out into a thin film. This film joins up with those formed by neighbouring droplets to give a continuous thin film which is repeatedly swept by successive charges of gaseous oil-fuel mixture. In such conditions, it would seem, most of the petrol remaining in the film evaporates. The remaining rich mixture of oil in petrol is capable of providing reasonably adequate lubrication under all except, perhaps, the severest operating conditions.

The rate of evaporation of petrol from the film depends on the temperature of the surface and the rate of gas flow over it. Thus, the crankcase, in addition to its other functions, acts as a film evaporator. Every successive charge of air and petroil-mist mixture pumped through the crankcase contributes its quota of oil to the films already formed, until these films become so thick that the surface tension effect is overcome. They then begin to flow and to form droplets of oil, relatively free from petrol, which tend to flow down and collect on the bottom of the crankcase. Then they are picked by the crankshaft balance weights and sprayed to every moving part of the engine. On those parts more exposed to the swirl of gases, oil films will be torn off in the form of fine droplets that will also become sprayed over the engine interior.

Unfortunately, not all the original mist entering the crankcase becomes deposited. In view of the high velocity of the mixture, a certain proportion of the mist is carried through to the combustion chamber, where nearly all of it becomes burnt. At the most, only a minor proportion of its oil component is able to provide upper cylinder lubrication for the piston. This is probably one of the chief reasons why the proportion of lubricant used in the petroil mixture is so high that the oil consumption of even small two-stroke engines may be as much as one gallon for 1,500 to 2,000 miles running.

Quite apart from considerations of oil economy, it is highly desirable to reduce to a minimum the amount of oil carried with the fuel-air mixture from the crankcase to the combustion chamber, so that the rate of carbon formed may be as low as possible. The ideal to be aimed at in the design of the engine is complete conversion of all the petroil mist entering the crankcase into neat oil on the one hand, and the petrol vapour on the other. Furthermore, as little as possible of the spray or mist of neat oil formed should be allowed to reach the combustion zone.

When small stationary two-stroke petrol engines of modest rating are running at constant, moderate speeds, the oil:petrol ratio may, in some cases,

be as low as 1:32, but laboratory tests have shown that air-cooled engines, when running continuously at full throttle with leaner oil:fuel mixtures, such as 1:64, suffer piston seizure. Even in moderately rated engines, say, 0·016 b.p.h. per cm^3 running at 2,500 r.p.m., the lowest oil:petrol ratio that can safely be used, at prolonged full throttle operation on the bench, is about 1:40 if piston seizure is to be avoided. In more highly rated engines, it is doubtful whether a ratio lower than about 1:24 is advisable, and 1:16 is commonly used to provide an ample margin of safety under actual road conditions.

Apart from its simplicity, reliability and low prime cost, the petroil system has several advantages over some of the other systems of lubrication used in two-stroke engines. One valuable feature is that the amount of oil supplied to the engine increases in proportion to its power output. Another is that there is no risk of oil starvation, due to leaks or breakages in the pipe lines or unions, such as may, for example, occur in the very ingenious Villiers automatic, gas-pressure system. The oil used is uncontaminated with decomposition products of used oil and incompletely burnt fuel. Air pressure, spring-loaded, or semi-automatic, gravity drip feed oil systems are often subject to undesirable variations of the rate of feed, with changes of atmospheric temperature.

Like most inexpensive systems, the petroil method of lubrication has its disadvantages. Perhaps the one most immediately apparent to the customer is the trouble involved in preparing the petroil mixture every time the vehicle is refuelled. Another drawback of the system is that the exterior of the carburettor and parts of the engine in its vicinity become covered with a film of oil to which dirt adheres. Furthermore, when descending long hills with the throttle closed, there is a danger of oil starvation.

In the opinion of Dr. Alan Wolf, however, these minor drawbacks are completely overshadowed, especially in the case of more highly rated engines of greater power output, by two fundamental defects of the petroil system. These are: the rate of oil feed to the engine must be strictly limited in the interests of economy and cleanliness in the combustion and exhaust zones and, owing to the incomplete evaporation of the petrol, such oil as does reach the moving parts of the engine is probably not as viscous as is desirable. It is true that this defect can, to a certain extent, be minimized by the use of relatively viscous oils, say S.A.E. 50 instead of S.A.E. 30 oils commonly recommended for the lubrication of small two-stroke engines. But the modern tendency is, in fact, in exactly the opposite direction. Oils of relatively low viscosity are used, such as S.A.E. 20 and even 10.

Mechanical considerations

The question then arises as to just how serious these disadvantages are from the mechanical point of view. It is true that gudgeon pin and piston ring wear, although not unduly high, are usually higher in the petroil-lubricated two-stroke engines than in circulation-oil four-stroke units. On the other hand, the modern practice of fitting roller-bearings to connecting rod big-ends and ball and, or, roller bearings for the crankshaft has greatly reduced the wear at these points. Ball and roller bearings only need enough oil to lubricate the slight slip which occurs between the balls or rollers and the races. Furthermore, owing to the fact that the piston is called upon to function as a valve, it is considerably larger than in four-stroke engines of similar capacity. Thus, the frictional surface of the piston is greater, with the result that the pressures per unit area on the piston skirt are lower.

A characteristic feature of two-stroke pistons is the absence of oil control rings, so that as large as possible a proportion of the oil on the lower parts of the cylinder walls reaches the upper part of the piston skirt and rings. Another condition makes it possible to obtain reasonably satisfactory lubrication by the petroil system, in spite of the absence of the positiveness associated with the circulating force-feed system. The bearing areas of the connecting rod big- and small-ends and of the crankshaft are relatively large, and compression ratios and specific power output moderate, so that bearing pressures per unit area are also moderate. At least to some extent, this compensates for the fact that, since every down-stroke of the piston is a power stroke, there is not the relief in bearing pressure that occurs in a four-stroke unit.

In the two-stroke engine, the small-end bearing is considered to operate in worse conditions than the big-end bearing. It has been found that under full load conditions, the temperature of the small end bush may reach the surprisingly high values of about 390–430 deg F, even in units developing a moderate b.h.p. at an unexceptional crankshaft speed. It is, indeed, remarkable that it should be found possible to mist-lubricate the small-end bearing at all under conditions of such high temperature and load.

Selection of lubricants

Not least among the benefits that would probably result from increasing the degree of separation of the oil and fuel in the crankcase would be the possibility of using oils of lower viscosity. Thus, if the fuel dilution of the oil in the crankcase was reduced to a minimum, it might be possible to use a S.A.E. 10 grade of motor oil, viscosity about 100 units at 130 deg F, instead of, say, a S.A.E. 30 oil having a viscosity of about 220 at 130 deg F.

The starting effort is approximately proportional to the viscosity of the oil at the cylinder wall temperature. It is apparent, therefore, that a change to the thinner oil would reduce this effort by more than a half when the engine is warm, and the difference would be very much higher with a cold engine. The reduction in the rate of carbon deposit formation in the case of the lower viscosity oils, is due to their containing a smaller proportion of the heavy components of such high boiling point as to resist evaporation, even at the maximum temperatures reached during the power stroke in the combustion zone of the engine.

Other properties besides that of viscosity must, of course, be taken into consideration when selecting the type of lubricant to be used. In fact, these principles apply irrespective of the lubrication system employed. In view of the fact that a fair proportion of the oil fed to the crankcase enters the combustion zone, it is important that its carbon-forming tendencies should be as low as possible. Furthermore, the supply of oil to the working surfaces is rather scanty. Therefore, the oiliness, or metal-wetting and metal-adhering power of the oils, is of greater importance than in full film lubrication. It is a fact that there is no definite broad relationship between oiliness and viscosity.

While the oil must have sufficient chemical stability to avoid the formation of lacquer-like deposits on piston skirts and in ring grooves, there is no need to place as much emphasis on the oxidation resistance of the oil as in the case of the re-circulating systems. This is fortunate, since it gives greater latitude in the selection of the oiliness additives.

It is maintained that, owing to the entry of oil spray into the combustion zone, and to the higher temperatures prevailing in the piston ring belt, the two-stroke engine is more prone to ring sticking than the four-stroke. In view of this, the so-called heavy-duty or full-detergent types of oil might be expected to be particularly suitable for small petrol two-stroke engines. Unfortunately, however, a characteristic feature of many types of detergent motor oils is that they have high carbon and ash forming tendencies. In justice to these oils as a class it should, however, be pointed out that they do not all behave in this manner. Those containing certain electrically-treated vegetable oils as the detergent dope might well prove to give results decidedly superior to ordinary straight mineral oils in two-stroke engines.

Anti-oxidant additives are commonly used in premium-grade motor oils, chiefly on account of their beneficial effects in reducing lacquer-formation on piston skirts. Such additives as do not appreciably increase the carbon and ash forming tendencies of the oil may well be desirable in two-stroke lubricants. However, they must not be of a type

that, at high temperatures, attacks phosphor bronze. This point needs bearing in mind since certain anti-oxidant additives are said to have a chemical action on this metal at temperatures higher than 300 deg F.

Two-stroke engines, as a matter of practical convenience, are designed to run satisfactorily when lubricated with the brands and grades of motor oil at present readily available to the public. However, the number of such units in use on the road is increasing rapidly. Therefore, the question of formulating grades of oil specially suited for two-stroke units will, no doubt, receive the serious consideration of the oil industry, particularly in connection with the dispensing of ready-mixed petroil.

Leaded Fuel

It is well known that in the two-stroke engine, sparking plugs are very much more liable to be fouled than in the four-stroke engine. What is perhaps less generally known is that this fouling increases with the lead content of the fuel. Chemical analysis almost always reveals a high percentage of lead compounds, often of the order of 40-60 per cent of the total deposit.

From this it will be clear that small two-stroke petrol engines would run best with petrol containing no tetraethyl lead at all. Unfortunately, such spirit is not available to the ordinary consumers. Moreover, the continual trend towards increasing the power output of two-stroke engines has necessitated raising the compression ratio of these power units to a point where they require a petrol of at least 70 octane rating if undue pinking is to be avoided. At present it is not economical to produce petrol of such octane rating without the incorporation of some T.E.L. in the fuel. The premium - grade, higher - octane, branded petrols which may be on sale in the future will no doubt contain more lead than the spirit at present available.

The exact reasons why fuels of relatively high T.E.L. content give much more plug trouble and contribute much more to heavy combustion chamber deposits in two-stroke than in four-stroke engines do not appear to be known. However, there must be little doubt that the greater incidence of plug fouling in two-strokes is due to oil spray entering the combustion chamber with the air-fuel vapour mixture and, in part, becoming deposited on the plugs. Since the oil droplets comprising the spray probably still contain quite substantial proportions of vaporized petrol, the T.E.L. which it contains will be brought into contact with the hot plug points and insulators in a relatively concentrated form. It would thus appear that the only possible way in which crankcase-scavenged two-stroke engines could be made to run, without undue plug trouble, on high octane petrols containing relatively large proportions of T.E.L. would be to reduce to a minimum the entry of oil spray and vaporized fuel into the combustion chamber.

Alternative lubrication systems

In two-stroke engines of a swept capacity higher than about 200 cm^3 per cylinder, petroil lubrication cannot as a rule be used with satisfaction under all running conditions. This is because the capacity increases approximately as the cube of the cylinder radius, whereas the cooling area increases only as the square of the radius.

However, since such engines are also of the crankcase-scavenged type, circulatory lubrication is not feasible because too much oil spray would be carried through the transfer ports into the combustion zone. If a forced-feed system is used, therefore, it can only be of the total-loss type, and the oil supply must be strictly limited.

It may be concluded that the oil separation problem has hitherto been regarded as too difficult to solve by inexpensive means. Obstacles to its solution are the high linear velocity of the mixture pumped through the crankcase, and the necessity for avoiding any undue obstruction in the path of the mixture. An additional serious difficulty is the relatively small amount of free space available in the crankcase.

Nevertheless, Dr. Alan Wolf is of the opinion that it may be possible to solve this problem and to lubricate the bearings positively without mechanical pumps. He states that it would not be surprising to see devices based on this principle incorporated in standard two-stroke engines in the not far distant future.

CHROMATE FINISHES

CHROMATE finishes are described by H. C. Irvin in *Product Finishing*, October 1951. Alternatively known as conversion coatings, they have in recent years gained wide popularity as finishes for zinc, cadmium, aluminium, copper, brass and bronze. The process is simple, requiring only the immersion of the parts in the chromate solution for a few seconds, usually at room temperature, and the thin coating produced by a chemical reaction is integral with the surface. The original hues of iridescent yellow, drab olive and deep bronze were first enriched by dyeing to black, red, blue or green, and later developments produced bright chromium-like finishes for zinc and cadmium.

In addition to their decorative value, the chromate films possess excellent corrosion resistance and provide a firm bond for paint. The thin bright coating is in appearance indistinguishable from chromium plate, although its resistance to abrasion is rather lower. Also, the bright films being the thinnest of all chromate finishes, offer less corrosion protection: 24-100 salt spray hours to white corrosion, against 100-200 hr for yellow, bronze or olive drab films. An increased corrosion resistance can, however, be secured by adding a coating of clear lacquer over the bright chromate film.

At present, the bulk of chromate finishes is employed on zinc, this metal being plentiful and lending itself to corrosion resistant and decorative products. Many commercial forms of zinc can be treated, such as plate, die castings, sheet and galvanized zinc. In the case of die-cast zinc, however, owing to the alloy content and the crystalline surface of the cast material, only heavy chromate films (yellow, bronze, olive) can be applied directly, bright finishes requiring a preliminary zinc-plating operation.

For imparting corrosion resistance alone, the simplest process, with one chromate tank and several rinse tanks, is used. When coloured or bright finish is desired, an additional tank containing the dye or the bleaching medium (phosphoric acid, caustic soda, etc.) and further rinse tanks must be included. All chromate solutions can be said to possess five basic characteristics: film forming, colour factor, chemical polishing, film inhibiting and self-bleaching. A chromate bath for any particular type of finish must possess the above characteristics in correct amount and relative proportion, as described in several examples with the aid of charts. (*M.I.R.A. Abstract No.* 5628.)

Fatigue of Welded Stiffeners and Panels

THE British Welding Research Association of 29, Park Crescent, London, W.1, have, in volume 5, No. 5 of their journal, published a report entitled "Fatigue Strength of Panels with Welded Angle Stiffeners" by R. Weck, Ph.D. Although the report deals almost entirely with structural design problems, on this subject, associated with shipbuilding, there is one section concerning the reinforcement of butt-welds that might be of general interest.

The relative merits of different types of reinforcement straps have been investigated. Only one type was found to be effective as a reinforcement of good quality butt-welds. One other type was found to improve fatigue strength of poor quality welds. (1993)

NEW PLANT AND TOOLS

Recent Developments in Production Equipment

MODERN German practice for tool grinding machines is exemplified by the Kraumendahl machines illustrated in Figs. 1 and 2. The machine shown in Fig. 1 is a Triax three-head tool grinder specially designed for convenient and rapid grinding of tungsten carbide tools. Each grinding wheel has its own individual motor drive and also has reversing switches so that each wheel can be run in either a clockwise or anti-clockwise direction. All the spindles are mounted in large precision roller bearings, which are protected by special oil seals.

There is an adjustable angle table for each grinding wheel position. This machine is so designed that all three heads can be used simultaneously by three operators, each of whom has sufficient room to manipulate the tools to be ground. As there are only two levers to be operated, setting up is easy. Provision is made for a copious supply of lubricant, which is drawn from amply proportioned settling tanks. All parts which cannot be painted, such as table guides and levers, are made from a special rust-resisting steel. A similar machine, but having four grinding heads is now also being manufactured. It is designated the Quart.

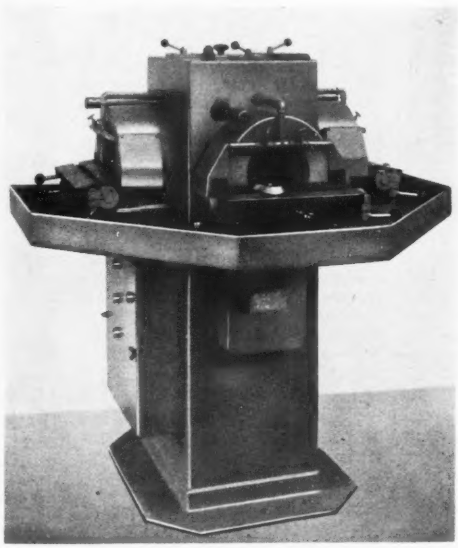


Fig. 1. Kraumendahl Triax three-head tool grinder

The machine illustrated in Fig. 2 is the Spanex. This has been specially designed for grinding chip breaker grooves in turning tools. As the illustration shows, the tool is ground by being held in position on an adjustable and tilting support table that can be swivelled in two directions. This construction allows the groove to be ground at any desired angle. A special adjustable setting gauge is fitted to the machine by the side of the grinding wheel, and the tool is clamped into position while its cutting edge is resting against the setting block. Table reciprocation is carried out by means of a conveniently placed lever. Chip breaker grooves can be ground in either large or small tools. A groove can be ground in a $1\frac{1}{2}$ in square tool in about two minutes, including the time for chucking and setting. The machine has a built-in motor drive, and the peripheral speed of the grinding wheel is so arranged that it is impossible for tungsten-carbide tips to crack due to over-heating during the grinding operation. If desired, this machine can be supplied with diamond impregnated grinding wheels, in place of the standard soft grinding wheel. Rockwell Machine Tool Co. Ltd., Welsh Harp, Edgware Road, London, N.W.2, are the British agents for these machines.

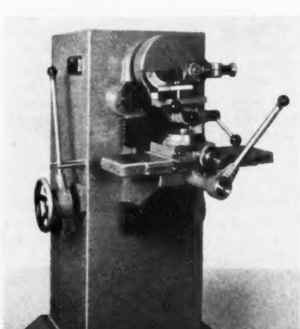


Fig. 2. Kraumendahl Spanex machine for grinding chip breaker grooves

Twin brushing machine

A recent addition to the range of brushing and polishing equipment manufactured by B. O. Morris Ltd., Briton Road, Coventry, is illustrated in Fig. 3. It is a twin-head brushing machine which is available in two models, M.151/4P and M.151/14P. The first gives 4 in projection from the centre line of the brushes to the front of the casing and the second a projection of 14 in. In all other respects both models have the same characteristics.

Any diameter of brushes from 3 in to 6 in can be used. The standard sizes are 3 in and 6 in, and any width of brush up to 2 in can be accommodated. Either $\frac{3}{8}$ in or $\frac{1}{2}$ in bore brushes may be used. The top brush is mounted on a spindle which is adjustable vertically by a screw feed and a locking nut to give any distance up to $\frac{3}{8}$ in between the brush peripheries. The machine is operated by a foot switch on which pressure must be maintained for continuous running. When the pressure is released the machine is automatically stopped. Inside the machine there is another switch which is fitted with thermal overload trips to cut-out the machine if over-heating occurs.

These machines are so designed that the brushes retain the workpiece for the guidance of the operator, and there is complete freedom from any tendency for the workpiece to be pulled into the brush. The weight application of the brush is determined by the angle of presentation to the work. For con-

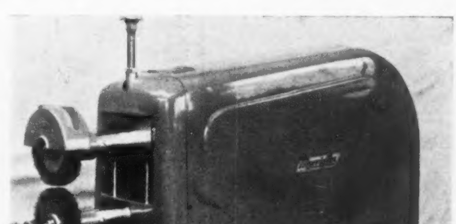


Fig. 3. B. O. Morris twin brushing machine

Fig. 4. Wild-Barfield horizontal general purpose furnace

venience in operation, the guards can be adjusted radially.

General purpose furnaces

Light-duty furnaces are often pressed beyond their normal working capacities of output and temperature range to meet a production schedule for which a full-scale production furnace would be too large, and therefore uneconomical. To meet the need for equipment that will bridge the gap between light-duty furnaces and large production plants, Wild-Barfield Electric Furnaces Limited, Elecfurn Works, Watford By-pass, Watford, Herts., have started the production of two horizontal and a vertical electric furnace.

This type of equipment must be suitable for many diverse applications. It must be flexible as regards temperature range, and must be suitable for a wide variety of shapes and sizes of work. In addition, such furnaces must be robust in construction, combine maximum utility with economy, and produce results fully comparable with those obtained from full-scale production plants. In brief, they must be general purpose furnaces.

The Wild-Barfield general purpose furnaces comprise two horizontal models and a vertical model. One of the horizontal models, the HW1 illustrated in Fig. 4, has a chamber 18 in long, 9 in wide and 5 in high, while the other, the HW2, has a chamber 31½ in long, 16 in wide and 5 in high. The vertical model, illustrated in Fig. 5, is designated VW1 and has a chamber 10 in in diameter × 20 in deep. Each of these furnaces has a maximum operating temperature of 1050 deg C (1922 deg F). This allows them to be used for a wide variety of heat-treatment operations.

Because of the usage to which general purpose furnaces are subjected, temperature control must be simple and safety devices must be incorporated. In the HW1 and VW1 models an energy regulator control panel has been found most satisfactory. When used in conjunction with a pyrometer it gives accurate results. For the larger horizontal model, the HW2, an indicating automatic controller is generally supplied. A door switch ensures that when the door is opened, the electricity supply to the elements is cut off so that the operator is in no danger from shock when removing the furnace charge. An excess temperature cut-out of the fusible type is incorporated in the control circuit.

A controlled atmosphere is essential for many heat-treatment operations. These furnaces can be adapted to incorporate the injection of such an atmosphere into the chamber. The choice and method for the controlled atmosphere plant depend upon the component to be treated and the most convenient supply available. In this respect the Paragen burner has many merits because of its compactness and the fact that the fuel required to provide the atmosphere is commercial paraffin.

These furnaces can be used for normalizing and annealing forgings and castings at all temperatures within the range. They can also be used for pack carburizing circular components such as gears and similar parts contained in cylindrical pots and boxes. The vertical type is particularly suitable for hardening single components of slender section and batches of work that can be suspended on jigs and quenched as a complete charge. The horizontal types are suitable for hardening of carbon and low alloy steel tools and parts. These parts may be placed either direct on the hearth, or small parts in large numbers may be placed in trays.

Inclined coil cradle

An addition to the range of press shop equipment manufactured in this country to the designs of the U.S. Tool Company Inc. is illustrated in Fig. 6. It is an automatically operated inclined coil cradle, that has been specifically designed to eliminate loading difficulties with heavy coils. In the use of this cradle, the coil is simply rolled into the cradle, a core is inserted and the coil is then lifted by a motorized jacking system built into the machine.

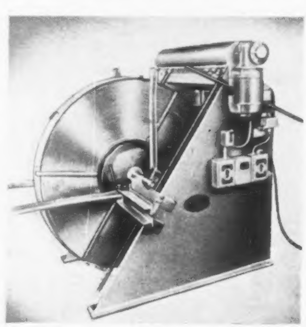


Fig. 6. Automatically operated inclined coil cradle

Fig. 5. Wild-Barfield vertical general purpose furnace

Two push button controls are provided. One is for controlling the jacking system and the other for controlling the motorized draw-off. There are two conventional rollers for gripping the material, and draw-off is controlled by the now well-proven mercury limit switch control from an arm resting on the catenary of the material. The normal draw-off speed is 54 ft per minute, but other speeds can be provided to suit individual requirements. The cradle will take coils up to 20 in width and 48 in outside diameter, and up to 3,000 lb weight. As a result of the special inclined construction, this unit takes the minimum of floor space. The basic frame is fabricated from steel, and the unit is robust and made for heavy service. The Rockwell Machine Tool Co. Ltd., Welsh Harp, Edgware Road, London, N.W.2, hold the manufacturing rights for the European market for this and the whole range of U.S. Tool Co. Inc. press equipment.

Machine Tool Exhibition

THE International Machine Tool Exhibition, London, 1952, will be held at Olympia from 17th September to 4th October inclusive. In addition to the wide range of British machine tools that will be exhibited, many machines from the United States of America, France, Germany, the Scandinavian countries, Holland and Italy will also be shown. Twenty thousand copies of a pre-exhibition catalogue have been sent to prospective visitors in all parts of the world.

STANDARDIZED COMPONENTS

Progress by the "Big Six" Committee

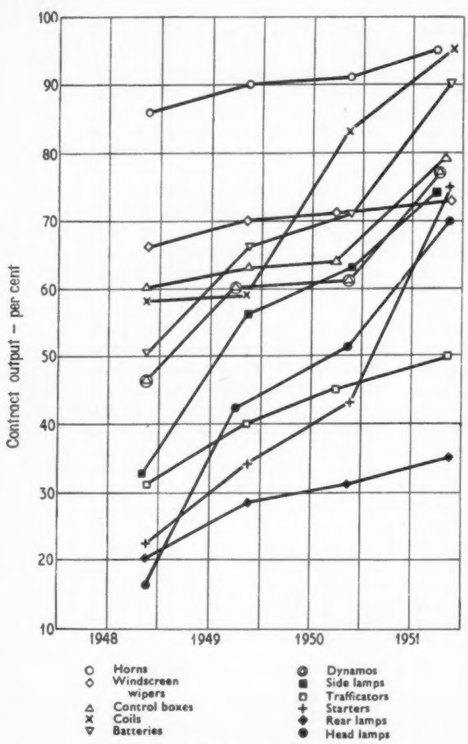
FOR a considerable time manufacturers have been incorporating standard components in new designs and, in some cases, substituting them for non-standard parts in current production models. However, it is only recently that a number of Standards Books have been completed and published. They have been produced in uniformly printed volumes, one for each subject, and can be obtained from the Society of Motor Manufacturers and Traders by its members and by any other technical body. Some of the subjects covered are: electrical equipment, wheels and tyres, body hardware, brakes, dampers, propeller shafts and instruments and engine equipment, including carburettors. It is intended that these books shall become the sole reference on the components concerned.

A meeting of the S.M.M. & T. sub-committee was held at Earl's Court on the 4th November, 1948, when it was decided that the most effective way of tackling the problem of standardization in the motor industry was for the "Big Six" manufacturers, representing approximately 87 per cent of the total output, to meet for discussion at regular intervals. Senior executives of the engineering and buying departments of each manufacturer were to be nominated, by each organization, to form what is now termed "The Big Six Standardization Sub-committee."

In addition to the main committee, further members have been co-opted, and some operative panels formed to deal with specialized equipment such as body hardware, truck brakes, road wheels and substitute materials. At most meetings the S.M.M. & T. has been represented and at some, when appropriate, representatives of the "Heavy Five" and senior executives of suppliers have attended.

The objectives of the committee are to promote the principles of standardization with reference to the products of the "Big Six" manufacturers. From this work widespread benefits are to be expected; tooling and production costs of the suppliers are cut by reducing the number of variations of each class of product; users of these goods, including manufacturers, will not need to carry such large stocks, thus both capital and storage space will be released to be more usefully employed. Research, experiment and development can be concentrated on fewer types instead of being duplicated or dissipated on many. Industry and the country as a whole will derive considerable economic benefit from reduced costs and quicker replacement services.

There is a danger that standardization might slow down progress and discourage initiative. However, the terms of reference of the committee have been framed to avoid these undesirable effects and to preserve the competitive spirit. In fact, there is no obligation on the part of any member to adopt the standards decided upon, although the advantages of so doing are not likely to be disregarded.



Target chart for electrical components

Each of the "Big Six" has sponsored certain subjects and, when meetings have been called, has acted as host to the other committee members and to relevant suppliers' representatives. As a result, members have visited each of the main factories in turn, and have had opportunities of comparing methods of administration and manufacture. Competition overseas, rather than in the home market, is critical, and a concerted effort is needed to rival successfully the very large manufacturing organizations in some foreign countries. Therefore, such an interchange of ideas has become ever more desirable now than in pre-war times.

The importance of this subsidiary outcome of the standardization meeting has been emphasized by the committee, which states: "Over and above the strict terms of reference, the senior engineers and purchase executives of the 'Big Six' have been drawn together to a degree never previously achieved during the history of the industry. This establishment of greater co-operation is likely to prove of the utmost benefit to the automobile industry in the future."

There is little doubt that the way in which these standardization measures have been effected approaches the ideal. Direct contact between responsible executives capable of taking quick decisions has resulted in the completion of the process in the shortest possible time. Moreover, by virtue of the close co-operation between component manufacturers and the industry, in the initial stages of the work, agreement has been reached on the question of making the fullest possible use of standard components. It would have been very difficult for an organization outside the industry, such as The British Standards Institute, to have

TABLE I.

	1949 Production	Present standards	Classified and special
Dynamos	21	3	3
Starters	27	3 (alternative drives)	—
Ignition coils	8	2	—
Distributors	13	3	2
Starter switches	7	3	—
Dipper switches (foot)	2	1	—
Control boxes	13	3	—
Headlamps	15	1 (three alt. bulbs) (two alt. rims)	4
Sidelamps	12	1	6
Stop, tail and number-plate lamps	23	2 (six alt. finishes)	6
Trafficators	7	1 (two alt. finishes)	2
Horns	15	2 (alternative feet)	2
Windscreen wipers	5	1	1
Lighting switches	15	—	3
Ignition switches	3	—	1
Totals	186	26	30

obtained comparable results in such a short time.

Some idea of the rate at which standardization is being introduced may be obtained from the target chart for electrical equipment. Furthermore, the tables illustrate just how great is the simplification achieved. This is even more remarkable in the case of electrical equipment as, for passenger cars and light vehicles, most of it is supplied by the firm of Joseph Lucas, Ltd., which had already established an appreciable measure of standardization before the present scheme was commenced.

After discussion of the relative merits of the different voltage systems, it was decided to adopt 12-volt equipment as standard. Many electrical components have to suit individual vehicle requirements as regards style. It has been necessary, therefore, to form another group of secondary standard items, listed in Table 1 as classified and special.

It would appear that a cost reduction of 2d. per wheel is the maximum that can be expected from wheel standardization, and this would inevitably entail modification of chassis parts. As a consequence, the subject needs careful consideration before useful standards can be laid down, and the standards book is not yet ready for issue. It has been agreed that 14 in, 15 in, 16 in and 17 in tyres shall be standard, and tyre sections are to vary in $\frac{1}{2}$ in steps e.g., 4.50 in, 5.00 in, and 5.50 in. Bolt pitch-circles of large and small diameters were discussed, the bias being in favour of the small circles. Agreement was reached that 60 deg seats be adopted for wheel nuts.

The brake standardization committee unanimously agreed that only dimensions affecting the installation of the brake system as a whole should be fixed, otherwise competition would be eliminated and technical progress obstructed. However, the number of brake sizes available is to be reduced by 30 per cent and limited to ten, varying from $7\times1\frac{1}{4}$ in to $12\times2\frac{1}{4}$ in. The introduction of unified threads will materially affect the standardization of hydraulic fittings.

Propeller shaft assemblies are reduced to include five different sizes of universal joints, four diameters of tube, and two tube wall thicknesses. This gives a range of seven different tube sizes. An effort has been made to control these dimensions, by quoting, for each size of tube three preferred lengths between joint centres Useful design charts are included.

The damper standards book contains particulars of two telescopic types, three wishbone lever-arm dampers, and three types of single lever arm damper. Included also are dimensions of levers and connecting links to be used in the whole range of cars manufactured by the "Big Six". That a considerable improvement by standardization has been effected is evident from the table.

Metric sizes have been adopted as standard for ball and roller bearings, and the elimination of inch sizes has resulted in a reduction of 50 per cent in the number of different bearings. Thin-wall bearings have also been considered. It has been agreed, for main bearings, to adopt eleven standard diameters with specified lengths for each, and two wall thicknesses. Standard connecting rod bearings are to be available with a range of fifteen diameters and two wall thicknesses, again there are agreed lengths.

Body hardware presented many problems to the sub-committee, who decided very wisely to retain, as far as possible, the freedom of the manufacturer to establish individuality as far as styling is concerned. In the course of discussion, the special requirements of the small low-cost car, calling for a degree of compromise in some instances, were kept in mind. Standards have been evolved for rear lamps, ashtrays, sun visors, driving mirrors, glass channels, boot-lid locks, interior grab handles, window regulators, and interior door handles. Consideration is to be given in the future to bonnet locks and safety catches, armrest fittings, door locks and door checks. It was agreed, with regard to bumper assemblies, that no standardization is possible owing to individual styling requirements. It is pointed out that the choice of two quoted basic rolled sections would generally be of benefit.

Another of the standards books covers instruments and engine fittings. Among the items listed are speedometers and flexible drives, pressure gauges and connections, fuel level gauges, radiator thermometers, electrical car-clocks, combined instruments, oil pressure switches, thermostat housings, car-heater connections, fuel pumps and carburettors.

TABLE II.

	1949 production	Present standards
Telescopic dampers		
Fixings		
Eye top and bottom	60	14
Eye top and stem bottom	51	14
Stem top and eye bottom	50	14
Stem top and bottom	61	14
Lever-operated-type dampers	21	6
Links	148	47
Link fixing, pins, etc.	75	3
Lever arms	130	70
Totals	596	182

MACHINERY AND ENGINE NOISE*

Its Measurement and Interpretation

By C. H. Bradbury, M.I.Mech.E.

A STUDY of noise by physicists and engineers is handicapped in that no two people hear a given noise exactly alike, and the recollection of a noise is liable to be inaccurate. Objective instruments for measuring noise exist, but the human experience and its effects, which are what concern the engineer, bear no simple and exact relationship to the readings of such a meter.

The frequency of noises arising, for example, from firing impulses in oil engines, or from gear teeth, bear a definite relationship to the speed of the machinery responsible for them, and are sometimes called "pitched" noises. "Unpitched" noises, usually shock-excited, are caused either by vibration at the natural frequency of the machine part, or be reverberation. The frequency of an unpitched noise, such as that caused by valve spring surge, bears no definite relationship to machine speed.

In machinery noise, both pitched and unpitched components occur. Pitched components often predominate where mass and stiffness are great, and unpitched components, which provide the bigger problems, in lighter constructions.

Methods of measurement

A microphone may be placed at equal intervals round the machine, extraneous noises being first suppressed. The average reading, expressed in decibels, is known as the general sound level. This method of measurement is of limited value, since the same average sound level may be recorded for very different noises.

*Abstracted from a paper entitled *The Measurement and Interpretation of Machinery Noise with Special Reference to Oil Engines*, presented to the Institution of Mechanical Engineers in December, 1951.

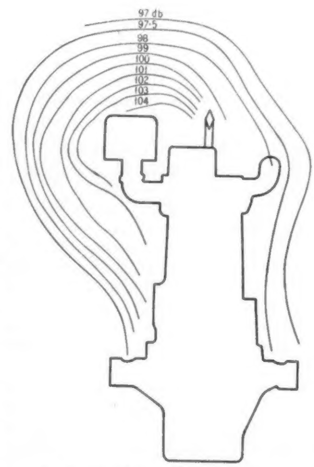


Fig. 1. Equal sound level contours

Alternatively, a microphone traverse may be made of a selected plane, the sound-level recordings being charted subsequently and points of equal sound level being joined by continuous lines to give equal sound-level contours. The contours, Fig. 1, are a guide to the source of a noise.

A frequency spectrum obtained by the narrow-band analysis shows which frequencies predominate, and often permits the source of the noise to be determined. In Fig. 2, for example, the peak at 75 c/s is at the oil-engine firing frequency, and the peak at 370 c/s corresponds to the turbo-charger speeds. If such a spectrum is taken at varying engine-speeds, peaks of pitched noise will assume positions, in relation to the frequency axis, in proportion to the speed, whereas unpitched peaks will be static. The general distribution of the noise measured may be indicated also by analysis into octaves, Fig. 3. Thus a variable band-pass filter selects sounds in octave ranges 37·5 to 75, 75 to 150 and up to 4,800 to 9,600 c/s, and again in the ranges 50 to 100, 100 to 200 and up to 6,400 to 12,800 c/s. The sound levels recorded at mid-band frequencies are plotted as ordinates.

The source of an unpitched peak having considerable magnitude and known frequency may be traced by setting the analyser at the frequency and making a single traverse. Bulges A and B in Fig. 4 indicated the source of a noise due to cavity resonance in a gear housing.

Interpretation of results

When a reduction of noise is required, difficulty lies in the interpretation of the data and in determining what constitutes objectionable noise rather than in measurement. In the spectrum of a three-cylinder, four-stroke oil engine running at 1,500 r.p.m., for example, the highest peaks could not be identified with certainty and the peak occurring at the firing frequency was relatively unimportant whereas those at five, six and eight times this frequency were considerable.

Spectra from a six-cylinder, four-stroke oil engine showed a clearly defined firing frequency at 1,000 r.p.m. that was almost totally suppressed at 1,250 r.p.m. Peaks were high in zones 40 to 60, 90 to 130, and 180 to 250 c/s, irrespective of the frequency per engine revolution. Some form of box resonance was indicated, therefore, but its cause was not clear. Two further spectra, taken while the engine was motored at 1,000 r.p.m., first

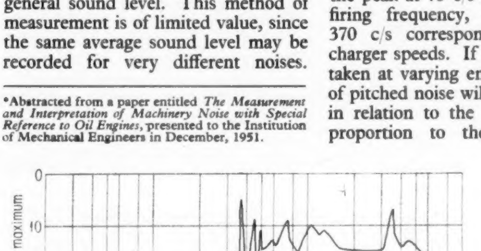


Fig. 2. Narrow-band analysis

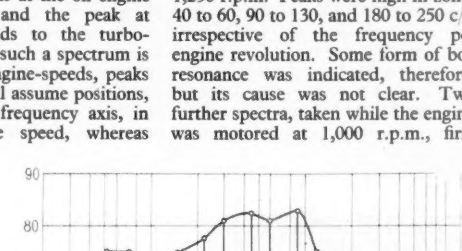


Fig. 3. Octave analysis

with pistons and secondly without pistons but with normal fuel injection, provided a clue to the major disturbances. It transpired that the 40 to 60 c/s zone was attributable to the piston stroke, while the fuel injection equipment excited the noise at 500 c/s and had some effect at lower frequency.

Spectra of noisy and quiet oil engines, and of compressors, showed that for quietness by subjective standards, the sound-level "hump" must be at the low-frequency end of the curve and that "peakiness" at the high-frequency end must be minimized. Low-frequency peaks are unimportant.

Reduction of noise

Noises are objectionable if they make conversation difficult or cause nervous strain. Of the machines tested, the worst offenders were those giving 80 db, or more, in the 1,000 to 5,000 c/s range. Consideration should be given mainly to sound reduction in the range of 200 to 10,000 c/s. This is well beyond the basic disturbing frequencies of the moving parts of the normal engine. The objectionable sound must have unpitched frequencies associated with the design, but it is impracticable to calculate all possible frequencies in the design stage, and design is conditioned by practical and economic factors. However, since

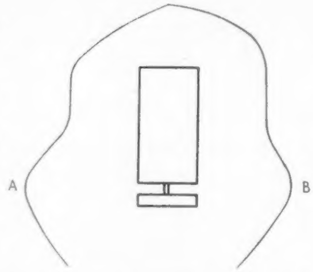


Fig. 4. Constant frequency contour, 400c/s

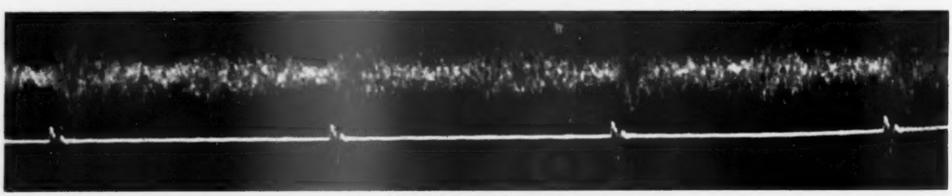
high-frequency sound is caused by shock-excited vibration, a primary object is to reduce shock-loading.

Noises are produced by the piston and connecting rod mechanism, firing impulse, valve gear and fuel-injection equipment. To give some idea of the relative importance of these parts or functions, three oscillograms of noise, from a single-cylinder engine (a) running normally (b) motored, and (c) motored with fuel-injection system in operation, are reproduced in Fig. 5. The kick on the trace corresponds to the injection timing, and the operation of the valve gear is discernible midway between injection points.

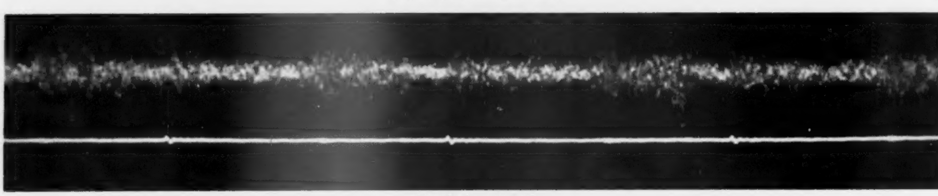
The main source of piston and connecting rod noise, Fig. 5b, is piston "slap" and bearing clearance. The use of low-expansion piston material, and control of the piston clearance shape from skirt to top ring, serve to reduce slap. That part of the piston from skirt to gudgeon pin, over which temperature varies little, might be made parallel, to act as a cross-head.

A principal contributor to noise is the firing impulse. Noisy combustion is almost certain to occur in the normal oil engine if the ratio of maximum- to compression-pressure is greater than 2 : 1, the amount of pressure rise being more important than rate of pressure rise.

If fuel pump reactions are transmitted to the camshaft, the velocities and accelerations of the valves are upset, and the silent valve operation, theoretically attainable, is not realized. Fuel-injection equipment may well itself be the main source of oil-engine noise. The sharp pressure rise followed by sharp cut-off at the end of injection, associated with high combustion efficiency, involve shock loading and shock release in the camshaft and fuel-pump support, and these react on valve gear and engine frame. The magnitude of this high-pressure noise in Fig. 5c is determined partly by the location of the fuel pump on the engine frame. It is most important that the pump should be adequately supported, the point of support being ribbed to obviate diaphragm effect, and the ribs



(a) Engine running normally



(b) Engine motored

(c) Engine motored with injection system in operation

Fig. 5. Sound records from single-cylinder oil engine

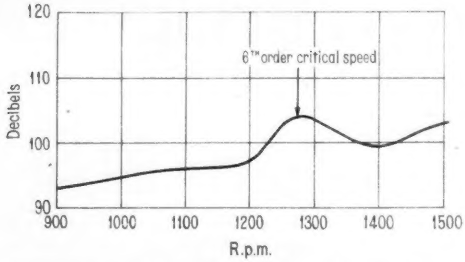


Fig. 6. Sound level readings showing effect of critical speed

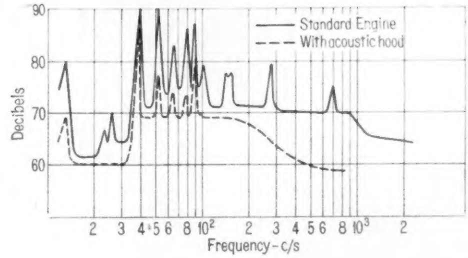


Fig. 7. Narrow-band spectra showing effect of acoustic hood

so located that cavity resonance cannot occur.

At critical crankshaft speeds in torsional vibration, the crankshaft journals oscillate across the bearing clearance, hammering the bearings at the critical frequency and producing a low rumbling noise. If the camshaft is driven from a point remote from the node, the vibration is transmitted to the valve gear, where a rattle is produced. Fig. 6 illustrates the effect of torsional vibration in a six-cylinder engine over a speed range including the sixth-order major critical speed.

Noise can be damped and, in general, the thicker and softer the jointing material, the quieter the engine. The joint between cylinder head, liner, and crankcase seems to be vitally important, and composition gaskets are usually held to be better, in relation to noise, than harder metallic rings.

The acoustic hood, which may, for example, have a frame of steel angle, outside cover of 16 S.W.G. aluminium and lining of glass wool 1½ in thick, positioned by expanded metal, is a means of quietening a stationary engine operating in a quiet residential district. Fig. 7 shows the effect of such a hood. The exhaust of this engine was carried away through the brick foundation.

FATIGUE OF WELDED STRUCTURES

AT a meeting of the South London branch of the *Institute of Welding* on the 10th January, 1952, Dr. R. Weck, Ing., Ph.D., presented a paper entitled "Some Practical Considerations in the Design of Welded Structures used under Fatigue Loading." Although the paper dealt with practical aspects of the subject applicable to a wide range of engineering problems, there was much of direct interest to the automobile engineer.

Dr. Weck stated that designers, after changing from a bolted or riveted structure to a welded one, were often dismayed at the early occurrence of fatigue failures. This did not mean that the fatigue strength of welded structures was necessarily inherently lower. In the case of the riveted structure, however, fatigue failure was not always characterized by the formation of cracks, but by rivets working loose, and in this way a redistribution of stress might take place. This could not occur in the more rigid welded structure. It was inherent in the form of the S-N curve that a small decrease in fatigue strength could result in a very large decrease in life. The introduction of a stress raiser by faulty welding or design, resulting in a comparatively small decrease in the fatigue strength, could lead to a very large decrease in the number of cycles to failure.

Stress concentrations are of far more importance in the design of structures used under fatigue loading than is generally appreciated. In fact, when fatigue is a governing consideration, the criterion of design should be the fatigue strength of the joints rather than the generally accepted criterion of average stress in the members. Butt-welds under fatigue loading are approximately twice as strong as fillet-welded joints. Since the fatigue strength of a welded joint does not depend on the size of the fillets but on the average stress in the members joined, gains in fatigue strength cannot be obtained by increasing the size of fillets but only by increasing the cross-sectional areas of the members joined by fillet welds.

Quality control of welding at the production stage is of vital importance. Apart from the ill-effects of the generally recognized defects, even excessive surface ripples can reduce the fatigue strength appreciably. The removal of reinforcement in butt welds by machining to produce a smooth contour is very beneficial, but this advantage can be lost if the removal is carried out by high-speed grinding. The scratches formed by this process can actually reduce the fatigue strength.

Where it is obvious that structures are subject to fatigue, electrodes giving deposits of high fatigue strength should be used. There is room for development work to provide filler metal of high fatigue resistance.

In structures constructed from thick plate, one inch and over, trouble from fatigue is frequently experienced because the carbon content in the thicker plate is likely to be higher than in the thinner plate in order to satisfy standard specifications with regard to tensile strength. With carbon contents of 0·25 per cent and over, cracking is likely to occur in the thick material. These cracks may not become apparent during manufacture but they may open up very quickly under fatigue loading and result in failure. Accordingly, when steels satisfy standard specifications with regard to tensile strength, fatigue failure is particularly likely to occur. In the larger thicknesses, it is by far preferable to use a steel of a rather lower tensile strength and having a carbon content not exceeding 0·2 per cent. Hardness cracks, which may have no effect, or very little effect, in structures subject to static loading may have a disastrous effect on fatigue life.

Testing of components is the only accurate way of estimating fatigue life. Only extremes of loading frequency have any effect on the results. At very low frequencies, in terms of cycles per minute, the fatigue strength may be slightly lower than normal, probably due to a combination of creep and fatigue, but once a frequency of about 5 cycles per minute is exceeded, frequency of loading has no effect on fatigue strength until the frequency reaches something in the order of 30,000 cycles per minute. Further increases would then result in an increase in fatigue life.

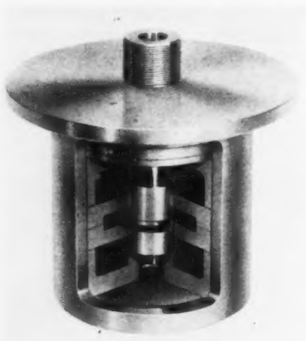
Student Library

AT the College of Technology and Commerce, Leicester, a new library of Engineering is to be opened shortly. One object is to provide a comprehensive collection of current trade catalogues, instruction handbooks and house journals. Such material will be greatly appreciated and should be addressed to the Chief Librarian, College of Technology and Commerce, Lero Buildings, Painter Street, Leicester. (1991)

THE S.E.I. CONVERTER

A Remotely Indicating Instrument for Measuring Mechanical Quantities

MEASURING equipment operating on the basic principle of a change of inductance in an electric circuit has hitherto been beset with difficulties arising from magnetic leakage, temperature errors and relatively poor electro-mechanical efficiency. In this instrument, developed by Salford Electrical Instruments Ltd. and the research laboratories of the General Electric Co. Ltd., such difficulties have been overcome, it is claimed, by the use of a new magnetic powder material termed "Gecalloy PL". The powder is moulded into a cylindrical core and used as the magnetic circuit of an electro-mechanical transducer. This may be regarded as an electrical transformer with a core that is moved by the originating mechanical force. The primary winding of the transformer is connected to A.C. mains through a step-down transformer while the secondary winding is connected to a special dynamometer-type indicator.



Transducer unit

Mechanical force on the movement is transferred to the magnetic core, which can be moved axially over a total distance of about 0·100 in from a central position inside the secondary windings. When the core is central, the secondary windings are balanced and the current is zero, but will increase proportionally as it is displaced. The coils in the converter are connected so that the magnetic flux flows through the core in the same direction as the very small external leakage flux. This makes it possible to house the core in a closely fitting metal tube, which ensures robustness and avoids losses and differential temperature errors.

The secondary windings of the converter are placed on the inside of the unit and are connected in opposition, after careful balancing, so that the voltage induced in each is neutralized when the moving core is exactly centralized. Alternatively, the core can be displaced a fixed amount and the windings altered so that the full travel of the core from one end of the gap to the other can be used to increase the range of the instrument. If desired, the core in the centre position can be connected to a centre-zero instrument so that differential measurements can be made.

Operation is from alternating current mains and the indications can be transmitted directly over several miles. Power consumption is very small and there are no amplifiers to maintain, contacts to keep clean or a multiplicity of moving parts to give trouble. Quantities can easily be summated, multiple indicators can be used and the inclusion of alarms, servo mechanisms or recorders presents no difficulties.

The system is simple and robust and can be operated and maintained by unskilled personnel. Overall accuracy is high and is unaffected by variations of ambient temperature. Up to 30 per cent change of voltage and 10 per cent change of frequency can be tolerated without the indications being affected, although neither of these extremes is likely to occur in practice.

The converter unit is an aluminium alloy case about 5 in long, with the operating spindle projecting through the centre of one end. The unit is sealed and is free from temperature error, so that it can be installed in exposed positions. It is connected to the indicator by means of a four-core electric cable sealed to the side of the unit. The two instruments together weigh less than 40 lb and the indicator can be installed at any required distance from the transmitter.

Of similar construction to the standard moving-coil switchboard instrument, the indicating instrument is normally of the flush-mounting, protected type with a 100 deg scale. The movement of the instrument is operated by an A.C. electro-magnet. The resulting torque for the instrument is appreciably greater than that of a comparable D.C. moving-coil instrument.

It is important to note that the combination of the converter unit and this special instrument is necessary to give an electrical performance that is independent of A.C. mains voltage and frequency fluctuations. Hence neither the converter nor the indicating instrument have practical applications when operated separately.

Indicating Instrument

The system has a very wide range of applications, of which the following are typical:

- Direct measurement of length up to 0·100 in
- Elongation or compression measurement
- Mechanical pressure
- Gas, liquid or steam pressure
- Instantaneous pressures caused by explosions
- Load indication
- Positional indication
- Liquid level indication
- Measurement of weight
- Temperature measurement

Although the equipment described above deals with the converter unit as a separate entity, certain types of mechanical equipment, such as pressure gauges, are being manufactured or developed with built-in converters. In these instances the electrical equipment is supplied separately in order that it can be adapted by the user.

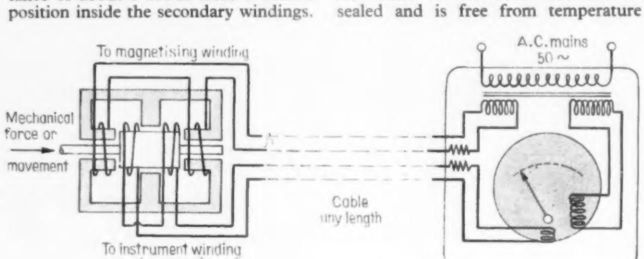
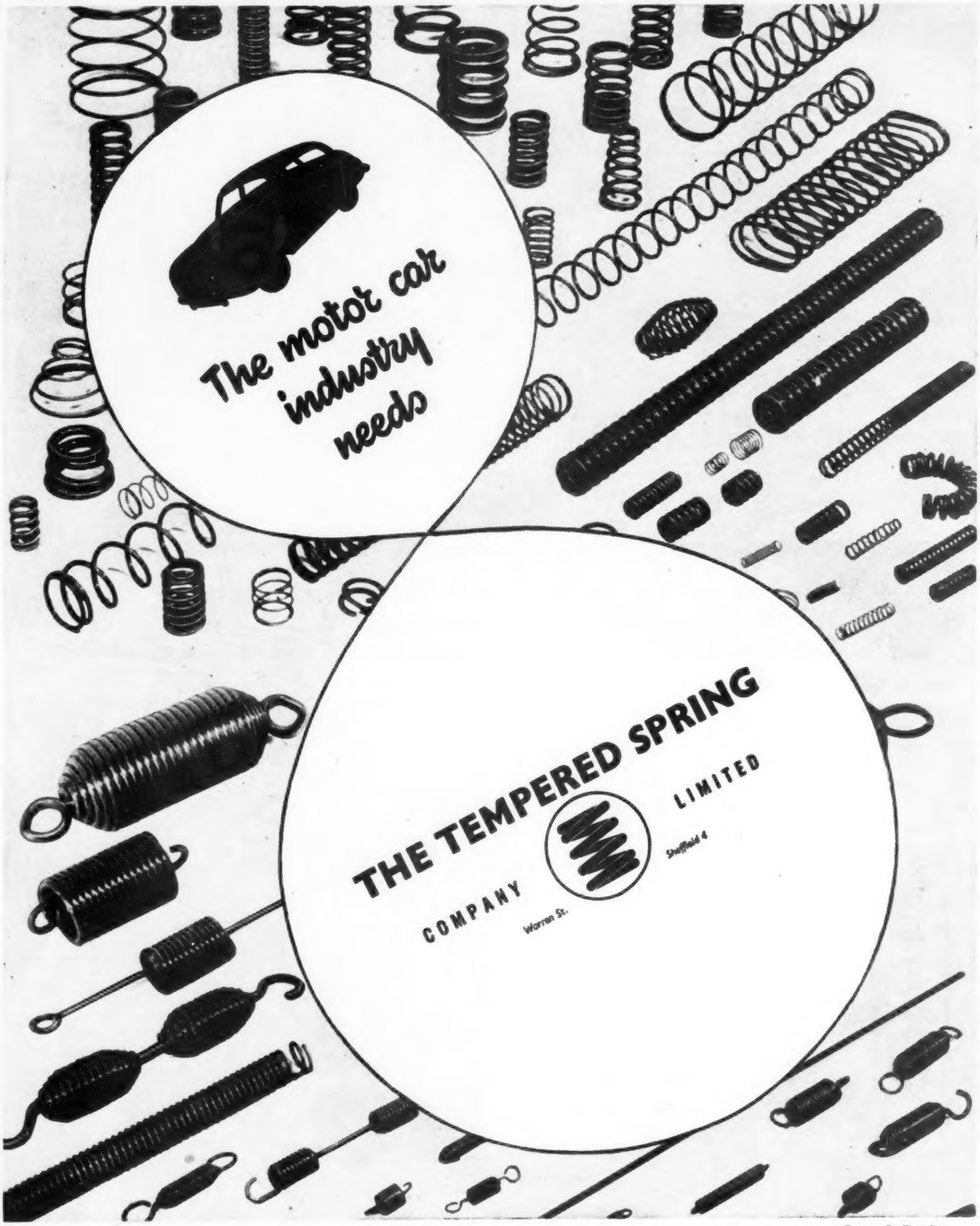


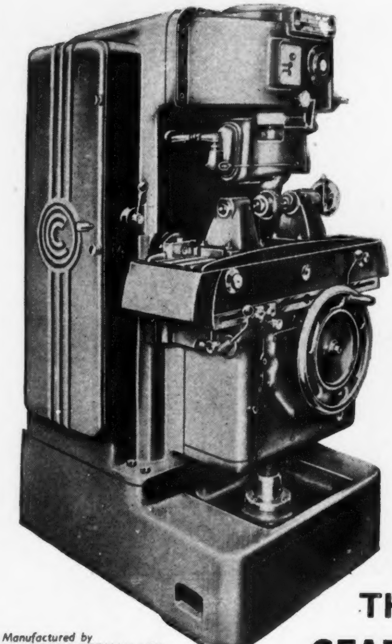
Diagram of connections

David Brown
GEARBOXES
with a background of nearly
a century of experience in the
manufacture of gears and gear
units for every application
DAVID BROWN
DAVID BROWN
& SONS (HUDDERSFIELD) LIMITED
HUDDERSFIELD ENGLAND

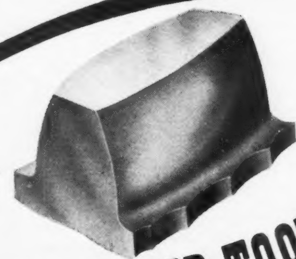


Stowe & Bowden

Constant calls for progress in design and still greater efficiency to keep abreast of new ideas, new materials and machines—these, as well as standard spring requirements for the motor industry are answered by the products of the Tempered Spring Company.



Manufactured by
CHURCHILL-REDMAN LTD
HALIFAX



THE ELLIPTOID TOOTH FORM

. . . . is the answer to some difficult gear problems, and is applicable to both spur and helical gears.

The Elliptoid tooth has both its horizontal section and vertical profile modified, and end thickness is always less than it is at any other point along the tooth, thus providing a perfect safeguard against end bearing.

Much higher tooth loads may be offered to an Elliptoid Tooth, therefore gear weight may be reduced without risk of stress failures.

THE RED RING GEAR SHAVER

CHARLES
CHURCHILL
& CO. LTD

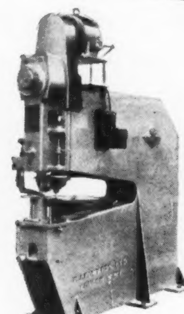
COVENTRY ROAD, SOUTH YARDLEY, BIRMINGHAM

Also at LONDON, MANCHESTER, GLASGOW, and NEWCASTLE-ON-TYNE

---

shape and form in SHEET METAL!

Today, shape and form in all sheet metal fabrication are of premier importance and therefore call for the use of first class equipment . . . such as those machines in the world famous range of Besco SHEET METAL WORKING MACHINES AND PRESSES. Too numerous in variety and size to advertise individually . . . we offer ALL machines for ALL operations in sheet metal !



Besco Universal Nibbler Shear. Fabricated steel plate construction. Two models to cut any shape in mild steel sheet up to $\frac{1}{8}$" and $\frac{1}{4}$" thick. Depth of throat 42". High speed motor drive. Registered Design Nos. 840977 and 853257.

F. J. EDWARDS LIMITED
359-361 EUSTON ROAD, LONDON, N.W.1

Telephones: Euston 4681 (7 lines) 3771 (4 lines)
Telegrams: Bescotools Norwest London

LANSDOWNE HOUSE,
41 WATER STREET, BIRMINGHAM, 3

Telephones: Central 7606-7
Telegrams: Bescotools, Birmingham 3

Do you need plastics for defence programmes ?

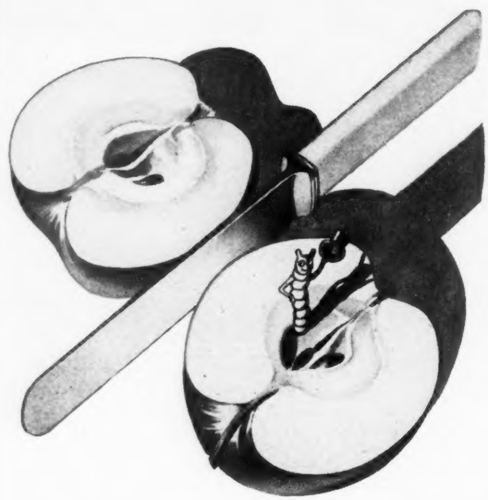
The new burden imposed on industry by the over-riding demands of defence production can be lightened from the outset by passing to EKCO Plastics problems involving high grade precision mouldings. EKCO take over complete production—down to final test and inspection by staff that is officially approved by A.I.D., Admiralty and other Government Departments.

EKCO

PLASTICS FOR INDUSTRY

Members of the British Plastics Federation and the Society of the Plastics Industries of America.

E. K. COLE LTD. (*Plastics Division*) SOUTHEND-ON-SEA



Well, Well... IT LOOKED PERFECT

Apples can be tested for flaws by cutting them open. And if there is no flaw you can always eat your apple. Welded joints and castings can be tested that way too — but if they're trouble-free, they won't be much use when you've finished. The way out of that difficulty is to use X-rays. They'll show up trouble if there is any, and leave your subject in one piece if there isn't.

We make and sell complete equipment for *non-destructive* testing of metals by X — and Gamma radiography. We also run an inspection service, sending out teams for on-site work, and examining smaller items in our laboratory. Please write for descriptive booklets.

solus-schall

X WE LOOK INTO THINGS

SOLUS-SCHALL LTD. (INDUSTRIAL RADIOGRAPHY)
18, New Cavendish St., London, W.1.
Tel: Welbeck 1212.

CRC-4

Has a fastening job put you 'on the spot'?

Why do the worrying when we've already done it for you? Dot Fasteners are made in a great variety of designs for a prodigious number of jobs—including yours probably. If not, our unique experience of fastening one thing to another will quickly find an answer. It's a sure way out of a problem to—

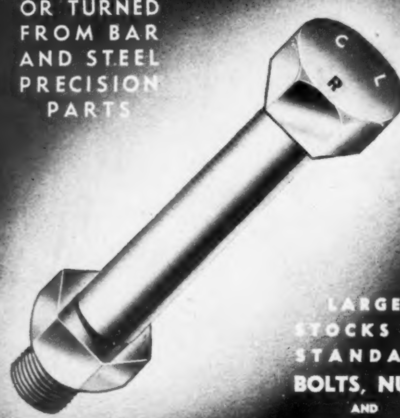
fasten on the **DOT** TRADE MARK

CARR FASTENER CO. LTD.
Stapleford, Nottingham. Telephone: Sandiacre 2234.

LINDLEY

for **HIGH GRADE BOLTS**

COLD HEADED OR TURNED FROM BAR AND STEEL PRECISION PARTS



LARGE STOCKS OF STANDARD **BOLTS, NUTS** AND **SET SCREWS**

C. LINDLEY & CO. LTD.
ENGLEFIELD ROAD, LONDON, N.1.
'Phone: CLISSOLD 0643 (4 lines) 'Grams: BEAUVOIR, NORDO, LONDON.

THE Dunelt RANGE OF HIGH QUALITY SPECIAL PURPOSE STEELS

SPECIAL ALLOY AND CARBON STEELS, Black Rolled, Bright Drawn or Smooth Ground, in the Heat Treated or untreated condition.

FREE CUTTING STEELS, HEATING RESISTING STEELS, DIE STEELS, SHEAR BLADE STEELS, HIGH SPEED TOOL STEELS, STAINLESS STEELS, VALVE STEELS.

"DUNELT" Hollow Steel Bars with holes of maximum smoothness assured by the "DUNELT" Patent Austenitic Process are available in rounds $\frac{5}{8}$in. to 3in. diameter, holes $\frac{3}{16}$in. to $\frac{7}{16}$in. diameter, in lengths up to 40ft. Squares, Octagons and Hexagons are also available.

Bars in diameters $1\frac{1}{4}$in. to 9in., lengths up to 20ft. supplied with bored holes $\frac{5}{8}$in. and upwards.

DUNFORD & ELLIOTT
(SHEFFIELD) LIMITED

Head Office: Attercliffe Wharf Works, Sheffield 9. Telephone Nos.: 41121 (5 lines). Telegrams: Blooms, Sheffield. Branches at: London and Birmingham.

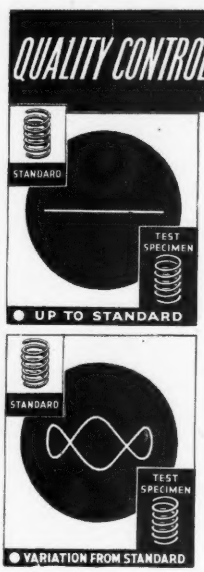
ENGINEERING DEPARTMENT—HEAT TREATMENT DEPARTMENT—BRIGHT DRAWING DEPARTMENT, Attercliffe: ROLLING MILLS, Attercliffe, and Clay Wheels Lane, Wadsley Bridge, Sheffield.

The Timken Roller Bearing Company of Canton, Ohio, U.S.A.

...announces that by the judgment of the United States District Court for the Northern District of Ohio, Eastern Division, in the case of United States of America vs. The Timken Roller Bearing Company, our agreement with British Timken Ltd., of Birmingham, England, and with Société Anonyme Française Timken, of Asnières, France, granting to those companies the exclusive right to sell tapered roller bearings in certain territories for original installation and imposing certain conditions upon sales by us of bearings for replacement purposes in those territories, has been terminated, and renewal thereof prohibited.

We may hereafter make sales of tapered roller bearings in any territory free of the restrictions formerly imposed by virtue of such agreement.

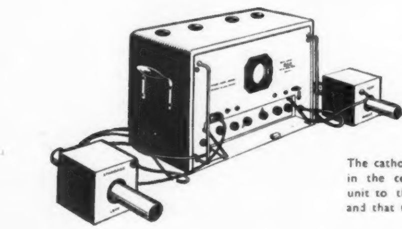
THE TIMKEN ROLLER BEARING COMPANY, CANTON 6, OHIO, U.S.A.



ELECTRONICALLY

A typical example from the range of electronic instruments is the G.E.C. Magnetic Sorting Bridge

Qualitative examination of ferro-magnetic components by electronic means is now an accomplished fact. Specimens are compared with a known selected standard, and any variations are immediately shown by the shape of the trace on the cathode ray tube which tells the routine tester as well as a practised observer in what way the specimen varies from standard. The very wide potentialities of the G.E.C. Magnetic Sorting Bridge are dealt with in a publication, No. X9835, available on request.



The cathode ray tube screen is shown in the centre of the instrument, the unit to the left containing the standard and that to the right the test specimen.

G.E.C. MAGNETIC SORTING BRIDGE

THE GENERAL ELECTRIC CO. LTD., MAGNET HOUSE, KINGSWAY, LONDON, W.C.2

For tenacity De Havilland's choose Permacel masking tapes

made by Johnson and Johnson

Permacel Cloth Tape used to bind strain gauges to propellers during fatigue tests. Inset: strain gauge indicator.

DURING HUNDREDS of hours of continuous vibration, the strain gauges attached to this aircraft propeller must stay precisely in position. That is why De Havilland's have chosen Permacel Cloth Masking Tape to bind them in place, for Permacel will adhere firmly to the smoothest surface. In addition to instant, sure adhesion, Permacel Cloth and Crepe Paper Tapes have two special advantages which lead to greater efficiency in production. They are resilient, and can be used effectively on sharp corners and irregular surfaces. They strip cleanly, leaving no sticky residue. The Paper Tapes, of course, are impervious to oils, acids and the chemicals normally used as solvents in paint and dope.

Permacel Cloth Tape used to fix paper masking on Comet wings and fuselage.

Stocks of all popular widths are available and orders for all sizes can be filled within the week.

Permacel

CELLULOSE SELF-SEALING TAPE

CLOTH AND 'DOUBLE BONDED'* CREPE PAPER MASKING TAPES

adhere instantly and firmly, strip easily and cleanly

* "Double Bonding" is an *exclusive* Johnson & Johnson process by which the adhesive is permanently bonded to the backing material.

For samples and quotations, please write to

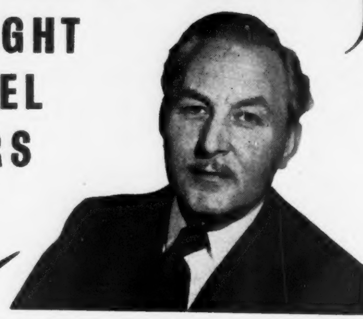
Johnson & Johnson (GT. BRITAIN) LTD. SLOUGH, BUCKS

Manufacturers of Permacel Cellulose Tape, Permacel (Crepe) Paper Tape and Permacel Cloth Tape

---

Engineers prefer KIRKSTALL

BRIGHT STEEL BARS



CARBON & ALLOY IN ALL STANDARD SECTIONS. ALSO SUPPLIED, FULLY HEAT TREATED, TO ENGINEERING SPECIFICATIONS.

KIRKSTALL FORGE ENGINEERING LTD

LEEDS 5 · TEL: HORSFORTH 2821

ABINGDON WORKS · KINGS RD · TYSELEY · BIRMINGHAM 11 · ENGLAND

B/E117/2


Enots
AND THE AUTOMOBILE INDUSTRY
Enots provide a wide range of Standard Equipment which is supplied to many leading vehicle manufacturers throughout the world. The photograph is by courtesy of The Bristol Aeroplane Co., Ltd.
BENTON & STONE LTD.
Aston Brook Street, Birmingham, 6
'PHONE: ASTON CROSS 1905
BRISTOL
2 LITRE


JJH
32" WIDE
Size is our only limit
maximum width 32"
minimum thickness
0015"
STRIP
STEEL
J·J·HABERSHON AND SONS LIMITED
Holmes Mills.. ROTHERHAM

CLASSIFIED ADVERTISEMENTS

RATE 4d. per word, minimum 4/-. Each paragraph charged separately. Box number 5 words—plus 1/-. Advertisements for the March, 1952, issue should be to hand not later than 1st post February 27th. No responsibility accepted for errors.

SITUATIONS VACANT

AUTOMOBILE Draughtsmen required. Men used to engine, transmission or chassis layout preferred. Apply Guy Motors, Ltd., Wolverhampton. [4421

SENIOR Jig and Tool Designers. We urgently need three or four first-class fully qualified men and are prepared to pay salaries in excess of A.E.S.D. rates according to experience and qualifications. Write, phone or call Henry Meadows Ltd., Fallings Park, Wolverhampton. [4499

MECHANICAL Engineers required for research and development associated with internal combustion engines and their fuel systems. Applicants should be of degree standard and consideration will be given to graduates without previous experience but who have a genuine interest in this class of work. The work is varied and provides excellent opportunities for keen young engineers capable of giving original thought to new problems. Reply to Personnel Manager, Joseph Lucas Ltd., Great King Street, Birmingham, giving details of qualifications, age and experience. [4497

HARRY FERGUSON Ltd. have a vacancy for a Senior Engine Designer to take charge of the Engine Design Section. Applicants should have had previous experience in the design of tractor, car or commercial vehicle engines. Also ability to initiate and execute new projects. The position is a responsible one and has good future prospects. Applicants should send fullest particulars of their age, education, qualifications and practical experience and salary required to The Secretary, Harry Ferguson Ltd., Coventry. [4495

DRAUGHTSMEN, Senior and Junior, experience of press and machine tools, jigs, fixtures, plant, etc., an advantage. Apply stating age, experience and salary required. Vandervell Products, Western Avenue, W.3. [4493

ENGINEER required by Ministry of Supply Establishment at Chertsey, Surrey. Qualifications: British, of British parentage. Recognised engineering apprenticeship, preferably in the body building industry. Corporate membership of one of the Institutions of Civil, Mechanical or Electrical Engineers or exempting qualifications. Membership of the Institute of British Carriage and Automobile Manufacturers or the Institution of Body Engineers an advantage. Considerable experience in the design, development and manufacture of all types of vehicle bodies, including those of all metal construction. Duties: Preparation of initial body arrangement drawings; liaison with contractors; compilation of specifications and examination of designs submitted by contractors. Salary: Within the range £860-£1,140 per annum. Not established, periodical competitions for established pensionable posts. Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26, King Street, London, S.W.1, quoting Reference No. C815/57A. Closing date, 28 February, 1952. [4491

SITUATIONS VACANT

SCOTTISH GAS BOARD—EDINBURGH DIVISION.

TRANSPORT AND WORKSHOPS SUPERINTENDENT.

APPLICATIONS are invited for the above position from candidates possessing a Higher National Certificate in Engineering or other appropriate qualification. Candidates should have experience in the organisation and maintenance of a fleet of commercial and private vehicles and contractors' plant and also a knowledge of workshops practice.

THE salary scale will be within A.P.T. Grade XI, £670-£795 per annum.

THE successful candidate will be subject to a medical examination and will be required to contribute to any Superannuation Scheme which may be adopted by the Board.

APPLICATIONS should reach the undersigned within 14 days of the publication of this advertisement.

DAVID BEAVIS, Divisional Controller, 15, Calton Hill, Edinburgh, 1. [4488

A WELL-KNOWN tyre company has opening for an Automobile Engineer as Technical Investigator. The work is of an interesting nature and will involve considerable travelling in this country. Applicants should be about 30 years of age, hold at least the H.N.C. in mechanical engineering and have had experience of design of chassis, bodies, braking and suspension systems. Please write in confidence, Box 6678, c/o Automobile Engineer. [4494

SITUATIONS VACANT

DESIGNERS. Ford Motor Company Ltd., Dagenham, urgently require first-class designers of not less than Ordinary National Certificate standard, having wide experience of car and truck chassis, engines and tractors. These are well paid staff appointments, and there is a generous non-contributory pension scheme. Reply to Salaried Personnel Department, quoting reference V/RD, giving brief details of qualifications and experience. [4487

ASSISTANT Buyer required for Caterpillar Tractor Co., Ltd., Coalville, Leicester, age 25-35, preferably with experience of the Automotive or ancillary industries; sal. £700-£750 p.a.

EXCELLENT openings exist for Designer-Draughtsmen, possessing the necessary qualifications and initiative, in the Drawing Office of a West Midlands works engaged in the production of I.C. engines, transmission and industrial sets. A Higher National Certificate or equivalent is essential for the Senior appointments. State experience and salary required. Box 5979 c/o Automobile Engineer. [4474

WANTED

WANTED, second-hand Steel Utility Body for 10 h.p. car. W. E. Dunn, 1, Victoria Square, Wolverhampton. [4498

WANTED, used leather transmission belting, used condenser rubbing leathers, industrial scrap leather. All weights bought. Write—Ets. Aouate, 2, Rue Veronese, Paris 13e, France.

MACHINERY WANTED

WANTED, all classes of machine tools, also presses and sheet metal working machinery of every description; best prices paid.

F. J. EDWARDS, Ltd., 359-361, Euston Rd., London, N.W.1. Tel. Euston 4681 and 3771. Telegrams: Bescotools, Norwest, London. [3407

PATENTS

THE proprietor of British Patent No. 613527, entitled "Two-stage hydraulic master cylinder," offers same for licence or otherwise to ensure practical working in Great Britain. Enquiries to Singer, Stern & Carlberg, 14 East Jackson Boulevard, Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 594687, entitled "Radial Pressure Clutch," offers same for licence or otherwise to ensure practical working in Great Britain. Enquiries to Singer, Stern & Carlberg, 14, East Jackson Boulevard, Chicago, 4, Illinois, U.S.A. [4486

THE proprietor of British Patent No. 557531, entitled "Brake Control Mechanism," offers same for licence or otherwise to ensure practical working in Great Britain. Enquiries to Singer, Stern & Carlberg, 14, East Jackson Boulevard, Chicago, 4, Illinois, U.S.A. [4480

CAPACITY AVAILABLE

DESIGN Capacity offered:

COMPETENT specialist advisory and design service offered on all types of car, truck and coach suspension systems by expert widely experienced in all aspects of vehicle springing. Box 5533 c/o Automobile Engineer. [4473

MISCELLANEOUS

STEAM Cleaning by the "Speedylectric" Mobile Steam Jet Cleaner with steam and detergent at finger-tip control will quickly disperse grease, oil and dirt. Fully automatic and totally enclosed. Just plug in and one man can do the work of five by other methods. Ideal for factories, machinery, garages, car chassis, etc. Send for Leaflet S.200. Bastian and Allen Ltd., Ferndale Terrace, Harrow, Middlesex. UNDerhill 0440. [4496

INDEX TO MANUFACTURERS' ANNOUNCEMENTS

Printed in Great Britain for the Publishers, ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1, by James Cond Ltd., Charlotte Street, Birmingham 3. "The Automobile Engineer" can be obtained abroad from the following: AUSTRALIA & NEW ZEALAND: Gordon & Gotch Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service Ltd. Gordon & Gotch Ltd. SOUTH AFRICA: Central News Agency Ltd. Wm. Dawson & Sons (S.A.) Ltd. UNITED STATES: The International News Co. Entered as Second Class Matter at the New York, U.S.A., Post Office.